الهيئة السعودية للتخصصات الصحية
Saudi Commission for Health Specialties

Diagnostic Radiology Board


بسم الله الرحمن الرحيم

PREFACE

The primary goal of this document is to enrich the training experience of postgraduate trainees by outlining the learning objectives for them to become independent and competent future practitioners.

This curriculum may contain sections outlining training regulation; however, details of such regulations need to be sought from the "General Bylaws of Training" and "Executive Policies" published by the Saudi Commission for Health Specialties (SCFHS), which can be accessed online through the official SCFHS website. In the event of discrepancy in regulation statements, that stated in the most up-to-date bylaws and executive policies will be the reference to apply.

As this curriculum is subject to periodic refinement, please refer to the electronic version posted online of the most up-to-date edition at www.scfhs.org.sa.

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II. COPYRIGHT STATEMENT

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III. FOREWORD

The Diagnostic Radiology Residency Curriculum Development Team acknowledges the valuable contributions and feedback of the scientific committee members and several radiologists in the development of this program. We extend special appreciation and gratitude to all the members whose contributions have been pivotal in the completion of this booklet, especially the Curriculum Group, the Curriculum Specialists, and the Scientific Council. We would also like to acknowledge that the CanMEDS framework is a copyright of the Royal College of Physicians and Surgeons of Canada, and many of the descriptions of competencies have been acquired from their resources.

IV. TABLE OF CONTENTS

V. INTRODUCTION

1.Context of Practice

Radiology is a branch of medicine that utilizes imaging technologies (such as X-rays, ultrasound, or magnetic resonance imaging) to diagnose diseases and guide diagnostic and therapeutic procedures. Wilhelm Conrad Roentgen's discovery of X-rays in 1896 marked the birth of this field (Thomas and Banerjee, 2013).

Radiology is an ever-evolving, growing field that is advancing at an incredible rate, particularly over the last few decades, with the emergence of new subspecialties and a redefinition of existing specialties. It is a fundamental part of modern medicine meeting the growing demands to guide diagnostics, aid in patient disposition, monitor treatment, and predict prognoses. Turf battles with other medical specialties, teleradiology, artificial intelligence, and deep learning represent ongoing challenges and opportunities that will shape the future of radiology. Therefore, radiologists' training journey must be comprehensive and dynamic, integrating academic knowledge and practical proficiency with the ever-growing body of research that drives the field. In addition to producing competent radiologists capable of performing various diagnostic and therapeutic tasks, the Saudi Board of Diagnostic Radiology aims to build a culture of continued excellence with a driving force to conduct relevant and beneficial research. This ensures that the Kingdom's needs and the 2030 Vision goals are best served, with a clear understanding of the region's cultural, ethical, and socioeconomic milieu.

Radiology deals with a wide array of pathologies (congenital, infectious, inflammatory, traumatic, neoplastic, etc.) on an urgent and elective basis, with increasingly busy service both day and night. It adds value to the health system through early diagnosis, increasing treating physician confidence,

decreasing patient anxiety, and boosting system efficiency. Screening programs (e.g., for breast cancer screening and hepatocellular carcinoma surveillance) and minimally invasive life-saving interventional radiology procedures are examples of how radiology has greatly impacted the health system (Bhandari and Dinh, 2017).

Although local statistics are scarce, there is clearly a high demand for highly qualified radiologists in most parts of the Kingdom. There has been an increase in well-structured radiology residency and fellowship programs in the Kingdom over the last decade in order to produce qualified radiologists. While expansion in such training programs has to be done wisely and gradually, the demand for radiologists, particularly in remote and rural areas, continues. Well-regulated teleradiology programs can help fill this gap, benefit remote and rural areas with highly qualified radiologists, and add value to the health system (Bhandari and Dinh, 2017).

References

(1) Thomas, Adrian MK, and Arpan K Banerjee. The history of radiology. OUP: Oxford, 2013

(2) Bhandari, Abdi, and Thy Dinh. The value of radiology in Canada. The Conference Board of Canada: Ottawa, 2017

2. Goal and Responsibility of Curriculum Implementation

The ultimate goal of this curriculum is to guide trainees to become competent in their specialty. Meeting this goal requires significant effort and coordination from all stakeholders in postgraduate training. As "adult-learners," trainees have to demonstrate full engagement with their proactive role through a careful understanding of learning objectives, self-directed learning, problem solving, openness and readiness to apply what they have learned from feedback and formative assessment through reflective practice, and self-wellbeing and seeking support when needed. The program director has a vital role in ensuring the successful implementation of this

curriculum. Training committee members, particularly the program administrator and chief resident, have a significant impact on program implementation. Trainees should be enabled to share the responsibility for curriculum implementation. The Saudi Commission for Health Specialties (SCFHS) will apply the best models of training governance to achieve the best quality of training. The Academic Affairs offices in training centers and regional supervisory training committees have a major role in training supervision and implementation. The Specialty Scientific Committee will be responsible for ensuring that the content of this curriculum is constantly updated to match the best-known standards in postgraduate education of their specialty.

3. What is New in This Edition?

This document refines and updates the 2015 version of the Diagnostic Radiology Curriculum with the goal of producing a safe general clinical radiologist who is able to understand his/her roles well (CanMEDS roles). Surveys and focused discussions with radiologists, program directors, and current and prior trainees have helped update this curriculum.

New additions into this version include:

- Greater emphasis on a competency-based curriculum, with explicit representation of learning domains (knowledge, skills, and attitude) and graded responsibilities for the trainee, with expected learning objectives that should be achieved at each stage of training (milestones). The goal is to establish better supervisory frameworks that support independent learning within a formal structure and enriched formative assessment.
- Rotations are changed from monthly rotations to a 4-week-block format, yielding 13 rotations per year instead of 12.
- The numbers of some rotations have been changed as follows:
  - Body CT Scan rotations are increased from 4 to 6.
  - Neuroradiology rotations are increased from 4 to 6.

- MSK Imaging rotations are increased from 4 to 5.
- Body MRI rotations are increased from 2 to 3.
- Fluoroscopy & Plain Films rotations are decreased from 3 to 2.
- Elective rotations are decreased from 4 to 3.

- Two rotations have been added to the new curriculum:
  - 1 Emergency Radiology / Plain Films rotation (in R1)
  - 1 Core Skills rotation (in R1)
- Two rotations have been omitted from the new curriculum:
  - General CT
  - General MRI
- Elective rotations now must include one of the following: Obstetric Ultrasound, Vascular Imaging, or Head and Neck Imaging.
- Assessment processes have been adjusted to be more robust, reliable, and valid, as follows:
  - Logbook, DOPS, and Mini-CEX scores are emphasized and assessed separately from the ITER. The rules for these assessment tools are defined.
  - The end-of-year progress test (EYPT) is now constructed locally (EYPT-Local) to replace the ACR exam (EYPT-International).
  - RADPrimer platform has been added as a formative assessment tool.

Because radiology, like other medical specialties, is dynamic and evolves over time, the curriculum is also expected to change. As a result, the curriculum will be periodically revised and updated.

VI. ABBREVIATIONS USED IN THIS DOCUMENT

Abbreviation	Description
SCFHS	Saudi Commission for Health Specialties
R1	First year of residency
R2	Second year of residency
R3	Third year of residency
R4	Fourth year of residency
OSCE	Objective Structured Clinical Examination
Mini-CEX	Mini-Clinical Evaluation Exercise
DOPS	Direct Observation of Procedural Skills
CBE	Competency-Based Education
ITER	In-Training Evaluation Report
EYPT	End-of-Year Progress Test
CanMEDS	Canadian Medical Education Directives for Specialists
QI	Quality Improvement
ALARA	As Low as Reasonably Achievable
PACS	Picture Archiving and Communication System
CT scan	Computed Tomography scan

MRI	Magnetic Resonance Imaging
US	Ultrasonography
NM	Nuclear Medicine
IR	Interventional Radiology
K	Knowledge
S	Skill
A	Attitude

VII. PROGRAM ENTRY REQUIREMENTS

In accordance with SCFHS training rules and regulations, the following requirements must be fulfilled by any candidate accepted into the training program:

- Must hold a medical degree, such as an MBBS or its equivalent from a university recognized by the SCFHS.
- Must have a certificate of internship completion.
- Must have passed the Saudi Medical Licensing Exam (SMLE).
- Must provide a comprehensive CV with references from two (2) consultants, preferably from the field of radiology, who should provide recommendation letters stating the suitability of the candidate for training in radiology.
- Must provide a letter from a sponsoring organization approving and pledging support for the candidate's total period of training, that is, four years, and for sponsored positions.
- Must sign a written pledge to abide by the rules and regulations of the training program and the SCFHS.
- Must be registered as a training radiologist at the SCFHS.
- Must have basic life support certification and malpractice insurance.

VIII. LEARNING AND COMPETENCIES

1. Introduction to Learning Outcomes and Competency-Based Education

Training should be guided by well-defined "*learning objectives*" that are driven by the targeted "*learning outcomes*" of a particular program to serve specific specialty needs. Learning outcomes are supposed to reflect the professional "*competencies*" and tasks that are aimed to be "*entrusted*" to trainees upon graduation. This will ensure that graduates meet the expected demands of the healthcare system and patient care in relation to their particular specialty. *Competency-based education* (CBE) is an "*adult-learning*" approach based on achieving *pre-defined, fine-grained,* and *well-paced* learning objectives that are driven by complex professional competencies.

Professional competencies related to healthcare are usually complex and contain a mixture of multiple learning domains (knowledge, skills, and attitude). CBE is expected to change the traditional way of postgraduate education. For instance, the time of training, though a precious resource, should not be taken as a proxy for *competence* (e.g., time of rotation in certain hospital areas is not the primary marker of competence achievement). Furthermore, CBE emphasizes the critical role of informed judgment of learners' competency progress, which is based on a staged and formative assessment that is driven by multiple workplace-based observations. Several CBE models have been developed for postgraduate education in healthcare (e.g., CanMEDS by the Royal College of Physicians and Surgeon of Canada (RCPSC), the CBME-Competency model by the Accreditation Council for Graduate Medical Education (ACGME), Tomorrow's Doctor in the UK, and multiple others). The following are concepts that enhance the implementation

of CBE in this curriculum:

- Competency: Competency is a cognitive construct that assesses the potential to perform efficiently in a given situation based on the standard of the profession. Professional roles (e.g., Expert, Advocate, Communicator, Leader, Scholar, Collaborator, and Professional) are used to define competency roles in order to apply them appropriately in learning and assessment.
- Milestones: Milestones are stages of the developmental journey throughout the competency continuum. Trainees throughout their learning journey, starting from the junior level and throughout the senior levels, will be assisted in transforming from (novice/supervised) to (master/unsupervised) practitioners. This should not undermine the role of supervisory/regulatory bodies in addressing the malpractice of independent practitioners. Milestones are expected to enhance the learning process by pacing training/assessment to match the developmental level of trainees (junior vs. senior).
- Learning Domains: Whenever possible, efforts should be directed to annotating the learning outcomes with the corresponding domain (K = Knowledge, S = Skills, and A = Attitude). More than one annotation might be used for a given learning outcome.
- Content-area Categorization: It is advisable to categorize learning outcomes in broad content areas related to the practice of the profession, such as diagnostic versus therapeutic, simple versus complex, and urgent versus chronic.

Trainees are expected to progress from the novice to the mastery level in a certain set of professional competencies. The SCFHS endorses the CanMEDS to articulate professional competencies. This curriculum applies the principles of competency-based medical education. As CanMEDS represents globally accepted frameworks that outline competency roles, the "CanMEDS

2015 Framework" has been adopted in this section.

This reference is an example of the general outline of the CanMEDS competency: Frank JR, Snell L, Sherbino J, editors. *CanMEDS 2015 Physician Competency Framework.* Ottawa, Royal College of Physicians and Surgeons of Canada, 2015.

2. Program Duration

The Diagnostic Radiology Residency Training Program is a 4-year (R1 through R4) full-time residency in accredited institutions, with continuous and final evaluations by way of examinations.

3. Program Rotations

The Diagnostic Radiology Residency Training Program has adopted the 4-week-block format since the 2020 training year. There are 13 rotations per training year and 52 rotations for the entire period of the training program. Each training year starts on October 1st.

The following table shows the distribution of radiology rotations over the four training years.

ROTATIONS (4-week blocks)	TRAINING YEAR (Number of Rotations)				TOTAL
	R1	R2	R3	R4	
Body CT Scan	2 [a]	2	1	1	6
Neuroradiology	2 [a]	1	1	2	6
Ultrasound	2 [a]	1	0	1	4
Chest Imaging	2 [a]	1	1	1	5
MSK Imaging [c]	1	2	1	1	5
NM/PET Imaging	0	2	1	1	4
Pediatric Imaging	0	2 [b]	1	1	4
Breast Imaging	1	1	0	1	3
Body MRI	0	1	1	1	3
Fluoroscopy & Plain Films	1	0	1	0	2

Emergency Radiology / Plain Films	1	0	0	0	1
Interventional Radiology [d]	0	0	2 [b]	1	3
Cardiac Imaging	0	0	1	0	1
Research/QI	0	0	1	0	1
Electives [e]	0	0	1	2	3
Core Skills [f]	1	0	0	0	1
TOTAL	13	13	13	13	52

a. One rotation must be completed before starting on-calls (i.e., within the first four blocks)

b. Preferably 2 rotations back-to-back

c. Includes MSK US

d. Includes Vascular US

e. Must include at least one of the following (either in R3 or R4): Obstetric US, Vascular Imaging, or Head and Neck Imaging. The AIRP course is optional and can replace any of the three elective blocks.

f. May include physics, reporting skills, non-interpretive skills, research basics, QI basics, and/or other courses/workshops.

Residents are entitled to four weeks of annual leave. Please refer to Section XIII (Policies and Procedures) for further details.

4. Mapping of Learning Objectives and Competency Roles to Program Rotations

4.1 Non-Medical Expert Roles

Learning objectives pertinent to non-medical-expert CanMEDS competency roles are nearly the same across different radiology program rotations. The following is the mapping of the learning objectives of such competency roles and the milestones where they should be achieved regardless of the rotation type.

4.1.1 Communicator

- Demonstrates respectful and effective response to consultation/imaging requests: *S, A*
  - R1-R2: Assesses and clearly responds to consultation/imaging requests; seeks help from seniors whenever appropriate. *S, A*
  - R1-R2: Assembles relevant clinical information pertinent to the requested imaging study/procedure. *S, A*
  - R3-R4: Discusses and assesses understanding of recommendations when providing consultation. *S, A*
- Respectfully discusses the imaging study/procedure with the supervising radiologists and correlates radiological findings with relevant clinical information in an organized manner: *S, A*
  - R1: Relates patient data and relevant medical history to the radiological findings. *S, A*
  - R2: Relates clinical findings and results of investigations to the radiological findings. *S, A*
  - R3-R4: Relates clinical findings, results of investigations, and multi-modality imaging results to the radiological findings. *S, A*

- Generates accurate, clear, concise, and complete radiology reports in accordance with guidelines (e.g., ACR guidelines), utilizing appropriate lexicons, describing relevant findings, providing differential diagnosis and likely diagnosis, and offering appropriate recommendations/action plans. *K, S, A*
  - R1: with some corrections
  - R2: does not require much correction
  - R3-R4: rarely requires corrections
  - R4: independently tailors the reports to meet the subspecialty guidelines and the caring physician's needs
- R1-R4: Demonstrates effective and compassionate communication skills with patients and relatives (e.g., to gather further clinical information, to explain contrast medium adverse reactions or procedural complications, or to explain the safety and hazards of the imaging study/procedure). *S, A*
- R1-R4: Demonstrates effective communication skills with referring physicians, technologists, supervising radiologists, and team members (e.g., to gather further clinical information or to deal with contrast medium adverse reactions). *S, A*
- R1-R2: Obtains informed consent, and explains to patients and their families the benefits and risks of basic imaging studies and their impact on patient management. *K, S, A*
- R3-R4: Obtains informed consent and explains to patients and their families the benefits and risks of image-guided interventions and their impact on patient management. *K, S, A*

4.1.2 Collaborator

- R1-R4: Judges when it is appropriate to seek support from seniors/radiologists. *S, A*
- R1-R4: Demonstrates appropriate interaction skills with other radiology department members to achieve a team approach to patient care. *A*

- R1-R4: Demonstrates good collaboration and consultation skills when interacting with clinicians and other health team members. *S, A*
- R1-R4: Demonstrates timely communication of urgent and critical findings directly with caring physicians. *A*
- R3-R4: Demonstrates timely communication of non-emergent findings where failure to act may adversely affect a patient's outcome. *A*
- R3-R4: Formulates and discusses the appropriate patient's imaging-related plan (multidisciplinary discussions). *S, A*

4.1.3 Leader

- R1-R4: Demonstrates appropriate time-management skills when performing various rotation tasks (arriving on time and prepared, ensuring the timeliness of the services provided, prioritizing patients' studies/procedures requests and reports based on urgency, promptly finalizing reports/maintain turn-around time (TAT) within institutional KPIs, ...). *S, A*
- R1-R4: Organizes and caries out different aspects of the rotation (teaching activities, service, on-calls, cases logbook, etc.) to meet requirements in a timely manner. *A*
- R1-R4: Carries out appropriate and timely actions to lead the situation for the patient's best interest (recommending the appropriate imaging investigation and selecting the proper imaging modality/protocol). *K, A*
- R1-R4: Identifies the physical and psychological needs of patients and their families (e.g., culture, social, and gender issues). *A*
- R1-R2: Recognizes the advantages and disadvantages of available imaging modalities. *K, A*
- R3-R4: Utilizes available resources effectively and efficiently based on indications and impact on patient care. *K, A*
- R2-R4: Evaluates, monitors, and optimizes the quality of performed studies and provides feedback to radiology technologists, such as recognizing artifacts, improper choice of parameters, or improper patient

positioning, and recognizes when images should be repeated or additional images should be acquired before discharging the patient (for example, additional mammographic images, additional ultrasound images, or additional MRI sequences). *K, S, A*

- R3-R4: Demonstrates the ability to appropriately handle clinical and technical questions from juniors, technologists, nurses, caring physicians, or administrative staff (e.g., answering technologists' questions related to imaging protocols, procedures, and policies). *K, A*

4.1.4 Health Advocate

- R1-R4: Recognizes the basic physical principles behind imaging studies and the associated protocols and techniques, and recognizes the effects of modifying scanning parameters on image quality and patient radiation dose. *K, S, A*
- R1-R4: Explains and illustrates for patients and referring physicians the appropriate use and abuse/misuse of different imaging modalities/procedures, and recommends upholding radiation safety measures. *S, A*
- R3-R4: Judges when a radiological study is unnecessary or unindicated, or if there is a better modality choice. *K, A*
- R1-R4: Recognizes appropriate contrast safety concerns (whether for CT scan, MRI, or interventional procedures), including indications, limitations, adverse effects, and proper management of adverse reactions: *K, S, A*
    - R1: Demonstrates knowledge of contrast reactions. *K*
    - R2: Recognizes contrast reactions (simulated or actual). S
    - R3: Practices, under supervision, managing patients who develop contrast reactions (simulated or actual). *S, A*
    - R4: Practices independently managing patients who develop contrast reactions (simulated or actual). *S, A*

- R2-R4: Recognizes appropriate MR safety principles (e.g., MR zones, contraindications, gadolinium-based contrast media, and their adverse effects). *K, A*
- R2-R4: Recognizes appropriate contrast safety concerns pertinent to different radio-tracers. *K, A*
- R1-R4: Recognizes and considers radiation doses and related consent issues when recommending, accepting, and protocoling cases: *K, S, A*
    - R1: Recognizes mechanisms of radiation injury and the concept of ALARA ("as low as reasonably achievable"). *K*
    - R2: Uses appropriate resources to ascertain exam-specific average radiation doses. *K, S*
    - R3-R4: Discusses the relative risk of exam-specific radiation exposure with patients. *K, S, A*
    - R1-R2: Applies ALARA principles in daily practice by ensuring justifiable indications of studies/procedures involving ionizing radiation for each patient. *S, A*
    - R1-R2: Applies appropriate techniques to minimize radiation exposure doses during studies/procedures for both the patient and staff. *S, A*
    - R3-R4: Recommends and advocates the use of non-ionizing modalities (ultrasound, MRI) whenever appropriate and feasible as an alternative to CT scans to minimize radiation risk. *S, A*
- R1-R4: Patient safety events in radiology department: *K, S, A*
    - R1: Recognizes common patient safety events and recognizes how to report them. *K*
    - R2: Identifies system points of failure resulting in patient safety events. *K, S*
    - R2: Uses institutional reporting systems to report patient safety events. *S, A*
    - R3: Practices and participates in analysis of patient safety events. *S, A*

- R3: Practices and participates in disclosing safety events for patients and families. *S, A*
- R4: Analyzes patient safety events and proposes strategies to prevent future errors. *S, A*
- R4: Develops basic expertise in disclosing safety events to patients and families. *S, A*

- R1-R4: Coordination of patient's care: *S, A*
  - R1-R2: Arranges and coordinates patients' care in a timely fashion in routine radiology studies/procedures, within the radiology department and with other services. *S, A*
  - R3-R4: Arranges and coordinates in a timely fashion, patients' care in complex radiology studies/procedures, within the radiology department and with other services. *S, A*
- R2-R4: Practices and participates in community- or facility-related activities to enhance patients' awareness (e.g., breast cancer screening campaigns). *K, S, A*

4.1.5 Scholar

- Utilizes evidence-based resources: *S, A*
  - R1: Utilizes evidence-based resources to determine the most appropriate imaging examination. *S, A*
  - R2: Utilizes evidence-based resources to determine the most appropriate management recommendations. *S, A*
  - R3-R4: Utilizes and critically appraises evidence-based resources to determine the most appropriate and up-to-date management recommendations tailored to individual patients. *S, A*
- Presents and discusses scholarly material: *S, A*
  - R1-R4: Carries out presentations and lectures in department grand rounds or journal clubs. *S, A*

- R1-R4: Practices and actively engages in group discussions during different rotation activities and demonstrates an understanding of the significance of self-assessment and self-directed learning. *S, A*
- R3-R4: Critiques and facilitates the learning of junior residents. *S, A*
- R3- R4: Demonstrates the ability to teach imaging practical skills (e.g., ultrasound scanning skills, fluoroscopic procedures) to junior residents, technologists, colleagues, and medical students. *S, A*

- R3: Carries out, under supervision, a research study or quality improvement project, and adheres to the principles of research and research ethics. *K, S, A*

4.1.6 Professional

- R1-R4: Demonstrates compassionate and patient-centered care. *S, A*
- R1-R4: Demonstrates respect to patients, and maintains their confidentiality. *A*
- R1-R2: Develops interprofessional relations. *S, A*
- R3-R4: Develops interprofessional relations, even in complex situations. *S, A*
- R1-R4: Demonstrates honesty, sense of responsibility, compassion. *A*
- R1-R4: Demonstrates respect for others, yet recognizes their limitations. *A*
- R1-R4: Demonstrates appropriate communication and professional appearance. *S, A*
- R1-R4: Demonstrates good work ethics, with enthusiasm and motivation to learn. *A*
- R1-R4: Demonstrates professional work habits (punctual, organized, efficient, available, and easily reached by other staff members). *S, A*
- R1-R4: Demonstrates accountability and reliability, and accepts responsibility for mistakes. *A*
- R1-R4: Recognizes the importance of feedback, accepts it, and incorporates it into improving personal performance. *S, A*

- Recognizes their own limitations and recognizes when it is appropriate to obtain help from seniors: *S, A*
  - R1: with assistance
  - R2-R4: independently
- R2-R4: Recognizes limitations of imaging studies/procedures. *K, A*
- R3-R4: Recognizes the ethical and medico-legal requirements of radiologists. *K, A*
- Designs and improves learning plans: *S, A*
  - R1-R4: Designs a reading and studying plan during rotation and works on showing progression from the beginning of the rotation toward the end. *S, A*
  - R1: Improves learning by seeking help and opportunities to identify gaps in actual performance and to meet level-appropriate expectations. *S, A*
  - R2: With assistance, improves learning plan, identifies gaps in actual performance, and meets level-appropriate expectations. *S, A*
  - R3: Independently improves the learning plan to close performance gaps and meets level-appropriate expectations. *S, A*
  - R4: Supports others (junior residents, interns, students, and off-service residents) to design and improve their learning plans. *S, A*
- Carries out required tasks on time: *S, A*
  - R1-R2: Responds promptly to requests or reminders to accomplish tasks on time. *S, A*
  - R3-R4: Independently carries out tasks on time to meet the needs of patients and care physicians/team. *S, A*
  - R4: Supports juniors complete their tasks on time. *S, A*

4.2 Medical Expert Role

The following section outlines the Medical Expert Role learning objectives for

each radiology rotation and maps them with their milestones.

4.2.1 Body CT Scan Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	2*	2	1	1	6

*One rotation must be completed before starting on-calls (i.e., within the first four blocks)

- R1: Explains how the CT images are obtained and formed: machine, patient preparation and positioning, and contrast media (done in 1st rotation). This requires attendance with CT technologists for a few days to: *K, S, A*
  - Illustrates the CT scan machine, how the patient is positioned, and how the images are acquired. *K, S*
  - Recognizes and observes the workflow from the technologist perspective. *S*
  - Recognizes the required patient preparation for the imaging study. *K, S*
  - Recognizes and observes how the technologist obtains the consent of patients. *K, S, A*
  - Recognizes and observes procedures undertaken for radiation dose reduction and protection. *K, S*
  - Recognizes and observes the steps undertaken for contrast media administration, and the safety issues and precautions undertaken by technologists. *K, S*
  - Recognizes and observes how image protocols are implemented, and how the timing of image acquisition after contrast medium administration is performed. *K, S*

- Recognizes and observes how image quality control is maintained, how changing imaging parameters can affect image quality, and how image artifacts are recognized and avoided/rectified. *K, S*
- Recognizes how technologists adapt examinations for difficult or risky patients' situations. *S, A*
- Recognizes and observes how image post-processing is performed, and how images are transferred to PACS. *K, S*

- Recognizes anatomy on abdominal CT scan: *K, S*
  - R1: Recognizes basic anatomy, including but not limited to abdominal organs, abdominal vessels, omentum, mesentery, peritoneum, and abdominal spaces. *K, S*
  - R2-4: Recognizes detailed and complex anatomy and anatomical variants. *K, S*
- Abdominal CT protocols: *K, S*
  - R1-R4: Recognizes the appropriate indications and contraindications for various abdominal CT protocols. *K, S*
  - R1: Selects the appropriate CT scan protocol for emergencies and common pathologies (must be done appropriately with limited assistance by the end of 1st rotation). *K, S*
  - R2: Selects the appropriate CT scan protocol for various clinical scenarios, including complex cases. *K, S*
  - R3: Modifies, after discussion with a radiologist, the CT scan protocol as mandated by clinical circumstances. *K, S, A*
  - R4: Independently selects the appropriate CT scan protocol (and modifies the CT scan protocol as needed). *K, S, A*
  - R3-R4: Understands advanced imaging techniques and problem-solving methods (e.g., dual energy imaging techniques). *K, S*
- Interpretation of abdominal CT scans: *K, S*
  - R1: Interprets abdominal CT scans performed for emergencies and common pathologies and understands their management: *K, S, A*

- Identifies primary and secondary imaging findings. By the end of 1st rotation, critical imaging findings must be identified without assistance. *K, S*
- Formulates differential diagnosis list, prioritizes differential diagnoses with assistance in 1st rotation, and with limited assistance in 2nd rotation. *K, S*
- Utilizes and obtains appropriate clinical information. *K, S, A*
- Recommends next appropriate step, with assistance. *K, S*

- R2: Interprets more complex abdominal CT scans (e.g., complex emergencies, cancer staging): *K, S, A*
  - Correlates CT findings with other imaging modalities. *K, S*
  - Formulates and ranks differential diagnosis list. *K, S*
  - Utilizes and obtains appropriate clinical information from multiple resources (for example, from patients, physicians, medical charts, and laboratories). *K, S, A*
  - Recommends next appropriate step. *K, S*
- R3-R4: Semi-independently interprets more complex abdominal CT scans for various pathologies and understands their management: *K, S, A*
  - Recognizes unusual imaging presentations of common pathologies. *K, S*
  - Generates an appropriate opinion and action plan on complex imaging findings. *K, S*
  - Correlates CT findings with other imaging modalities and additional clinical information (e.g., laboratory results). *K, S*
  - Formulates a shortened differential diagnosis list (provides a single diagnosis or few diagnoses). *K, S*
  - Distinguishes different stages of common malignancies. *K, S*
  - Recommends and discusses the most appropriate next step in patient management according to current guidelines, and considers cost effectiveness and risk-benefit analysis. *K, S, A*

- Identifies and manages reactions to contrast media: *K, S, A*
  - R1: with assistance. *K, S*
  - R2: with supervision. *K, S*
  - R3-R4: independently; supports and teach juniors to manage contrast media reactions. *K, S, A*
- Imaging artifacts and technical problems encountered in abdominal CT: *K, S, A*
  - R2: Recognizes common imaging artifacts and technical problems encountered in abdominal CT scans. *K, S*
  - R3-R4: Discusses imaging artifacts and technical problems with CT technologists to optimize image quality whenever artifacts or technical problems are encountered. *K, S. A*
- R4: Independently selects an appropriate CT scan protocol (and modify the CT protocol as needed), collaborates with the imaging team to optimize image quality, interprets various abdominal CT scans, and formulates complete and actionable radiology consultations and recommendations at the expected level of a subspecialist radiologist. *K, S, A*

Useful reading material: Please refer to Appendix A

4.2.2 Neuroradiology Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	2*	1	1	2	6

*One rotation must be completed before starting on-calls (i.e., within the first four blocks)

- R1: Explains how the CT images are obtained and formed: machine, patient preparation and positioning, and contrast media (done in 1st rotation). This requires attendance with CT technologists for a few days to: *K, S, A*

- Illustrates the CT scan machine, how the patient is positioned, and how the images are acquired. *K, S*
- Recognizes and observes the workflow from the technologist's perspective. *K, A*
- Recognizes the required patient preparation for the imaging study. *K, S, A*
- Recognizes and observes how technologist obtains the consent of the patients. *K, S, A*
- Recognizes and observes procedures undertaken for radiation dose reduction and protection. *K, S*
- Recognizes and observes the steps undertaken for contrast media administration, and the safety issues and precautions undertaken by technologists. *K, S*
- Recognizes and observes how image protocols are implemented, and how the timing of image acquisition after contrast medium administration is performed. *K, S*
- Recognizes and observes how image quality control is maintained, how changing imaging parameters can affect image quality, and how image artifacts are recognized and avoided/rectified. *K, S*
- Recognizes how technologists adapt examinations for difficult or risky patients' situations. *S, A*
- Recognizes and observes how image post-processing is performed, and how images are transferred to PACS. *K, S*

- **R1:**
  - Identifies CT and MRI imaging anatomy of the brain and neck. *K, S*
  - Identifies relevant vascular and spine anatomy and common normal variants. *K, S*
  - Recognizes and detects urgent and semi-urgent neurologic, head and neck, spinal, and neurovascular diseases. *K, S*
  - Recognizes the different CT imaging protocols for various clinical indications. *K, S*

- Identifies primary imaging findings and basic imaging differential diagnosis. *K, S*
- Recalls and discusses the basic imaging physics for diagnostic radiology in general and for neuroimaging in particular. *K*

- **R2:**
  - Applies knowledge of anatomy and pathophysiology to formulate differential diagnoses and make common neuroradiology imaging diagnoses. *K, S*
  - Identifies secondary and critical imaging findings on both CT and MRI and formulates modality-specific differential diagnoses. *K, S*
  - Relates pathophysiology knowledge of neurologic diseases and differential diagnosis. *K, S*
  - Applies knowledge of different CT protocols in imaging the brain, spine, and neck. *S*
  - Recalls the different MR sequences used in neuroimaging. *K, S*
  - Recognizes MRI and CT protocols, techniques, and physics. *K, S*
- **R3:**
  - Applies knowledge of neuroanatomy, pathology, and basic medical science to make common and uncommon imaging diagnoses. *S*
  - Applies knowledge of different indications to choose the proper imaging MRI protocol. *S*
  - Prioritizes differential diagnoses and recommends management options. *S, A*
  - Independently formulates a radiological impression and gives proper recommendations. *S, A*
- **R4:**
  - Proficiently relates and integrates knowledge of anatomy and imaging with pathophysiology to formulate a diagnosis. *S*
  - Chooses and provides a single diagnosis, when possible, and integrates current guidelines for appropriate recommendations. *S, A*

- Applies and discusses with technologists' strategies to optimize image quality, mitigate artifacts, and reduce radiation doses. *S, A*

Useful reading material: Please refer to Appendix A

4.2.3 Ultrasound Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	2*	1	0	1	4

*One rotation must be completed before starting on-calls (i.e., within the first four blocks)

- Ultrasound physics:
  - R1: Explains the basic physical principles of diagnostic ultrasound, including the basic physics of sound transmission, transducer design, transducer types and applications, image formation and interpretation, and potential artifacts. *K, S*
  - R2-R4: Explains the physics of duplex and color Doppler ultrasound, basic Doppler spectral analysis, and methods of quality control. *K, S*
- Scanning skills & Interpretation and reporting skills:

  Scanning skills must be the main responsibility during R1 rotation, with a gradual increase in interpretation and reporting responsibility toward the end of R1 through R2 and R4. Residents should continue to practice scanning techniques and gradually assume responsibility for each ultrasound examination, subsequently reviewing each case with the radiologist prior to reporting.
  - R1: Carries out, with supervision, a complete ultrasound examination of the abdomen and pelvis (starting the scanner, selecting the appropriate transducer(s), optimizing the imaging gray scale and Doppler parameters, etc.). *S, A*
  - R1: With supervision, carries out scanning and interpretation of emergency ultrasound studies, for example, acute cholecystitis,

testicular torsion, deep vein thrombosis, etc. This competency should be achieved by the end of first R1 ultrasound rotation, and further mastered in the second R1 ultrasound rotation. *S, A*

- R2-R4: Carries out scanning and interpretation of small organ ultrasound studies (e.g., thyroid and scrotum) and performs gynecological ultrasound examination, including transvaginal scanning, in addition to routine imaging. *S, A*
- R2-R4: Carries out scanning and interpretation of basic duplex Doppler studies, such as Doppler venous studies, upper and lower extremity studies, and carotid and renal artery studies. *S, A*
- R2-R4: Evaluates and optimizes the image parameters: power output, gain, and time gain compensation. *S*
- R1-R4: Demonstrates standard ultrasound imaging protocols for each routine examination. (Published protocols from the American Institute of Ultrasound in Medicine (AIUM) or the American College of Radiology (ACR), with or without local modifications, are acceptable frames of reference). *K, S, A*
- R1-R2: Recognizes the sonographic anatomy of the abdomen and pelvis. *K, S*
- R1-R4: Recognizes sonographic anatomy of various anatomic areas. *K, S*
- R1-R2: Identifies common abdominal/pelvic abnormalities encountered in daily practice. *K, S*
- R1-R2: Recognizes general diagnostic criteria used to evaluate tissue characteristics and to distinguish normal from abnormal, cystic from solid, etc. *K, S*
- R1-R2: Recognizes the clinical applications, advantages, and limitations of ultrasound. *K, S, A*
- R2-R4: Utilizes other imaging studies to complement ultrasound. *S, A*
- R1-R2: Discusses and observes ultrasound-guided interventional procedures, if available in the institution, and understands their

advantages and limitations. Examples include aspiration (tissue masses, fluid collection), biopsy, and catheter placement (pleural, peritoneal, and other fluid collection). *S, A*

- R2-R4: Discusses and participates in ultrasound-guided biopsies as delegated by the supervising radiologist, once the expected level of skills in scanning has been achieved (this may be accomplished alternatively during interventional rotations). *S, A*
- R4: Carries out advanced ultrasound scanning (e.g., advanced arterial/venous Doppler, transplant US). *S, A*

- Supervises the sonographers and ensures quality control: *K, S, A*
  - R2: Recognizes common imaging artifacts and technical problems encountered in ultrasound. *K, S*
  - R4: Discusses with ultrasound technologists to optimize image quality whenever artifacts or technical problems are encountered. *S, A*

Useful reading material: Please refer to Appendix A

4.2.4 Chest Imaging Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	2*	1	1	1	5

*One rotation should be completed before starting on-calls (i.e., within the first four blocks)

- R1:
  - Explains how the chest radiographs and CT scan images are obtained and formed: machine, patient preparation and positioning, and contrast media (done in 1st rotation). This requires attendance with CT scan technologists and radiographers for a few days in order to: *K, S, A*
    - Illustrate the chest X-ray machine, how the patient is positioned, and how the images are acquired. *K, S*

- Illustrate the CT scan machine, how the patient is positioned, and how the images are acquired. *K, S*
- Recognize and observe the workflow from the technologist perspective. *K, A*
- Recognize the required patient preparation for the imaging study. *K, S, A*
- Recognize and observe how the technologist obtains the consent of the patients. *K, S, A*
- Recognize and observe procedures undertaken for radiation dose reduction and protection. *K, S*
- Recognize and observe the steps undertaken for contrast media administration, and the safety issues and precautions undertaken by technologists. *K, S*
- Recognize and observe how image protocols are implemented, and how the timing of image acquisition after contrast medium administration is performed. *K, S*
- Recognize and observe how image quality control is maintained, how changing imaging parameters can affect image quality, and how image artifacts are recognized and avoided/rectified. *K, S*
- Recognize how technologists adapt examinations for difficult or risky patients' situations. *S, A*
- Recognize and observe how image post-processing is performed, and how images are transferred to PACS. *K, S*

- Recognizes the anatomy of the mediastinal compartments, mediastinal vessels, lungs, and pleura on both CXR and CT scans. *K, S*
- Recognizes the different views of CXR and their indications. *K, S*
- Lists indications of chest CT scan. *K*
- Develops a basic approach to CXR interpretation and how to recognize airspace disease, pulmonary edema, atelectasis, pleural effusion, and pneumothorax. *K, S*

- Carries out basic interpretation of chest CT, especially emergency scans like aortic angiograms, trauma CT, and CT pulmonary angiography studies. *K, S*

- **R2:**
  - Recognizes the normal anatomy and the different anatomical variants in the chest and how to differentiate them from pathology. *K, S*
  - Recognizes the physics behind how CXR and different chest CTs are obtained and how to improve image quality. *K*
  - Selects, with help, appropriate imaging protocols based on the indications and patient-related morbidities. *S, A*
  - Develops a systematic approach to interpret CXR and chest CT. *K, S*
  - Develops a practical approach to abnormalities found on CXR and is prepared to independently interpret CXR and recognize critical findings. *K, S, A*
  - Develops an approach to interstitial lung disease and draws differential diagnosis. *K, S*
  - Identifies and manages contrast-related complications. *K, S, A*
- **R3-R4:**
  - Selects appropriate chest CT protocols, taking into consideration the indication of the exam and patients' morbidities. *S, A*
  - Correlates chest physiology and basic pathology with the radiological findings. *K, S*
  - Develops an approach to mediastinal masses and considers what other imaging modalities are available for workup. *K, S*
  - Demonstrates logical thinking and interpretation of findings, correlating them to patient presentation and other investigations. *K, S*
  - Interprets CXR independently and manages critical findings upon detecting them. *S, A*
  - Interprets, diagnoses, and stages intrathoracic malignancies including lung cancer, mesothelioma, and mediastinal malignancies. *K, S*

- Interprets interstitial lung disease and differentiates between different etiologies. *K, S*
- Recognizes chest MRI protocols and how to interpret them. *K, S*
- Recognizes thoracic interventional procedures, is familiar with the complications, and how to handle them. *K, S, A*
- Identifies and manages contrast-related complications. *K, S, A*

Useful reading material: Please refer to Appendix A

4.2.5 Musculoskeletal (MSK) Imaging Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	1	2	1	1	5

- **R1:**
  - Recognizes conventional musculoskeletal radiographic techniques, special views, and correct positioning. *K, S*
  - Recognizes musculoskeletal radiographic anatomy. *K, S*
  - Recognizes clinical indications for musculoskeletal radiography and urgent CT and MRI exams. *K, S*
  - Explains the appropriate applications of general radiography, fluoroscopy, ultrasound, CT scan, MRI, and interventional procedures. *K, S, A*
  - Recognizes radiological anatomy and normal variations in the peripheral and axial skeleton, including the relevant anatomy of the bone, soft tissues, and joints. *K, S*
  - Recognizes and accurately describes various types of fractures and dislocations, and explains their types and classifications. *K, S*
  - Develops an approach for the assessment and diagnosis of musculoskeletal tumors and tumor-like lesions, in particular the

radiographic features discriminating non-aggressive from aggressive bone lesions. *K, S*

- Describes the typical radiographic features of common bone neoplasms. *K, S*
- Describes musculoskeletal infections (osteomyelitis, septic arthritis, discitis). *K, S*
- Develops a basic systematic approach for interpreting common joint diseases and diagnosing different types of arthritis. *K, S*

- **R2:**
  - Correlates musculoskeletal imaging findings with pathology. *K, S*
  - Recognizes radiological anatomy and normal variants of the spine. *K, S*
  - Recognizes normal MRI anatomy of the shoulder, elbow, wrist, hip, knee, and ankle joints. *K, S*
  - Identifies and describes MRI findings of common knee and shoulder pathologies. *K, S*
  - Identifies and describes orthopedic hardware complications (e.g., appendicular and axial fixation complications and arthroplasty hardware complications). *K, S*
  - Formulates an approach to bone lesion differential diagnosis based on the patient's age, lesion location, and lesion imaging features (zone of transition, matrix, morphology, periosteal reaction, cortical involvement, and soft tissue extension). *K, S*
  - Describes the typical radiologic features of common bone neoplasm. *K, S*
- **R3:**
  - Demonstrates greater efficiency in dealing with plain film exams and diagnoses, CT and MR interpretations, and case management. *S, A*
  - Explains the techniques of performing musculoskeletal ultrasound studies. *K, S*
  - Carries out MSK ultrasound studies. *S, A*

- Identifies and describes MRI findings of common hip and ankle pathologies. *K, S*
- Identifies and describes MRI findings of common elbow and wrist injuries and pathologies. *K, S*
- Identifies and describes MRI findings of common cervical, thoracic, and lumbar spine pathologies. *K, S*
- Applies the indications, contraindications, and post-procedural complication management of musculoskeletal image-guided procedures. *S, A*
- Discusses and participates in performing image-guided musculoskeletal interventional procedures, including joint arthrograms, joint block, and joint aspiration under supervision. *S, A*

- **R4:**
  - Recognizes musculoskeletal radiologic findings of endocrine diseases (e.g., renal osteodystrophy, hyperparathyroidism, osteomalacia/rickets) and explains the pathophysiology of such findings. *K, S*
  - Recognizes radiological findings of hematopoietic and storage diseases, including sickle cell anemia, thalassemia, mastocytosis, and Gaucher's disease. *K, S*
  - Demonstrates a systematic approach to relatively common dysplasias and congenital conditions such as achondroplasia, osteogenesis imperfecta, and osteopetrosis. *K, S*
  - Carries out and participates in performing image-guided musculoskeletal interventional procedures including joint arthrograms, joint block, joint aspiration, drainage, and biopsies under supervision. *S, A*

Useful reading material: Please refer to Appendix A

4.2.6 Nuclear Medicine / PET Imaging Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	0	2	1	1	4

- **R2 – 1st rotation:**
  - Explains how the nuclear emission images are obtained and formed (interaction with matter, radioactive decay, radioisotope production, machine, patient preparation, and positioning). This requires attendance with NM technologists for a few days in order to: *K, S, A*
    - Illustrate the NM machine and explain how the images are acquired and how the patient is positioned. *K, S, A*
    - Recognize and observe the workflow from the technologist's perspective. *K, S*
    - Recognize the required patient preparation for the imaging study. *K, S*
    - Recognize and observe how the technologist obtains the consent of patients. *K, S, A*
    - Recognize and observe procedures undertaken for radiation dose reduction and protection. *K, S*
    - Recognize and observe the steps undertaken for radiotracer administration, and the safety issues and precautions undertaken by technologists. *K, S*
    - Recognize and observe how image protocols are implemented, and how the timing of image acquisition after radiotracer administration is performed. *K, S*
    - Recognize and observe how image quality control is maintained, how changing imaging parameters can affect image quality, and how image artifacts are recognized and avoided/rectified. *K, S*
    - Recognize how technologists adapt examinations for difficult or risky patients' situations. *S, A*

        - Recognize and observe how image post-processing is performed, and how images are transferred to PACS. *K, S*
    - Recognizes basic QA of radiopharmacy and Gamma cameras. *K, S*
    - Recognizes the appropriate indications and contraindications for various general NM studies. *K, S*
    - Interprets common general NM studies (bone, renal, thyroid, parathyroid, and V/Q) and common pathologies and understand their management. *K, S*
    - Identifies primary and secondary imaging findings with a focus on critical imaging findings. *K, S*
    - Formulates differential diagnosis list. Prioritizes differential diagnoses with assistance. *K, S*
    - Utilizes and obtains appropriate clinical information. *K, S*
    - Recommends next appropriate step, with assistance. *K, S*
    - Identifies and manages radioactive accidents, with assistance. *K, S*
- R2 – 2nd rotation:
    - Recognizes common imaging artifacts and technical problems encountered in planar and SPECT/CT. *K, S*
    - Recognizes the appropriate indications and contraindications for various general NM studies. *K, S*
    - Selects the appropriate imaging protocol for various clinical scenarios (including complex cases) and suggests additional imaging or views with assistance. *K, S*
    - Interprets more complex general NM scans (e.g., MIBG, Meckel's). *K, S*
    - Correlates NM scan findings with other imaging modalities. *K, S*
    - Formulates and ranks differential diagnosis list, with limited assistance. *K, S*
    - Utilizes and obtains appropriate clinical information from multiple resources (including patient, physician, medical chart, lab). *K, S*
    - Recommends next appropriate step. *K, S*
    - Identifies and manages radioactive accidents, with supervision. *K, S, A*

- R3:
  - Discusses with NM technologists to optimize image quality whenever artifacts or technical problems are encountered with assistance. *K, S, A*
  - Recognizes protocols and image findings on more complex general NM scans (e.g., nuclear cardiology including different stressing protocols and ECG gating) and radionuclide therapy procedures (e.g., radioactive iodine therapy for thyroid cancer and hyperthyroidism). *K, S*
  - Recognizes advanced imaging techniques and problem-solving methods (e.g., cell labeling techniques and SPECT VQ scan). *K, S*
  - Semi-independently interprets more complex general NM scans performed for various pathologies and understands their management. *K, S*
  - Recognizes unusual imaging presentations of common pathologies. *K, S*
  - Generates an appropriate opinion and action plan on complex imaging findings. *K, S*
  - Correlates NM findings with other imaging modalities and additional clinical information (e.g., laboratory results). *K, S*
  - Formulates a shortened differential diagnosis list (provides a single diagnosis or few diagnoses). *K, S*
  - Distinguishes different stages of common malignancies. *K, S*
  - Recommends and discusses next appropriate imaging investigation or follow-up. *K, S, A*
  - Identifies and manages radioactive accidents with supervision, and teaches juniors. *K, S, A*
- R4:
  - Recognizes the basis of PET radioisotope production and QA of PET/CT cameras. *K, S*

- Recognizes the appropriate indications, contraindications, and protocols for PET/CT studies, including patient preparation. *K, S*
- Interprets F18-FDG PET/CT oncologic and neurologic scans and common pathologies and understands their management. *K, S*
- Identifies primary and secondary imaging findings on PET with a focus on critical imaging findings. *K, S*
- Formulates differential diagnosis list. Prioritizes differential diagnoses with assistance. *K, S*
- Utilizes and obtains appropriate clinical information. *K, S*
- Recommends the most appropriate next step in patient management, according to current guidelines, and considers cost effectiveness and risk-benefit analysis. *K, S, A*
- Identifies and manages radioactive accidents with appreciation of national legislative frameworks, and teaches juniors. *K, S, A*

Useful reading material: Please refer to Appendix A

4.2.7 Pediatric Imaging Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	0	2*	1	1	4

*Preferably two rotations back-to-back

- **R2:**
  - Recognizes the normal growth and developmental changes in children of all ages, and identifies normal variations. *K, S*
  - Identifies imaging findings of common and urgent pediatric pathologies. *K, S*
  - Describes the basic pathophysiology responsible for the various imaging patterns of common and urgent pediatric pathologies. *K, S*

- Recognizes appropriate patient positioning and contrast media usage for pediatric fluoroscopic procedures. *K, S, A*
- Recognizes the differences in performing ultrasound examinations tailored to pediatric patients. *K, S, A*
- Recognizes the technical aspects of basic pediatric CT and MRI examinations and pediatric-tailored protocols. *K, S, A*
- Develops a systematic approach for the interpretation of pediatric examinations to help narrow the differential diagnosis. *K, S*
- Interprets basic emergency radiology studies. *K, S*
- Identifies proper indications for the pediatric imaging exams. *K, S, A*

- **R3:**
  - Identifies abnormalities in normal growth and developmental changes in children of all ages. *K, S*
  - Describes and identifies imaging findings of a wide range of pediatric pathologies. *K, S*
  - Describes the basic pathophysiology responsible for various imaging patterns in pediatric pathologies. *K, S*
  - Performs fluoroscopic and ultrasound examinations tailored to pediatric patients. *S, A*
  - Describes basic CT and MRI protocols tailored to pediatric patients. *K, S, A*
  - Interprets pediatric examinations in a comprehensive approach emphasizing a useful and limited differential diagnosis. *K, S*
  - Interprets basic emergency imaging studies and recognizes how to manage pediatric patients independently. *K, S, A*
  - Recognizes appropriate indications and limitations of imaging studies. *K, S, A*
- **R4:**
  - Identifies abnormalities in normal growth and developmental changes in children of all ages. *K, S*

- Describes and identifies imaging findings wide range of pediatric pathologies. *K, S*
- Interprets X-rays and perform fluoroscopic and ultrasound examinations independently. *S, A*
- Describes CT and MRI protocols tailored to pediatric patients and supervises technologists in the performance of such studies. *S, A*
- Interprets pediatric examination in a comprehensive approach emphasizing a useful and limited differential diagnosis. *K, S*
- Recognizes sedation protocols, and recognizes the role of pediatric radiologists, anesthesiologists, nurses, and respiratory technologists in examinations performed under sedation or general anesthesia. *K, S, A*
- Judges which radiologic studies are more appropriate for the work-up of emergent and common clinical problems. *K, S, A*

Useful reading material: Please refer to Appendix A

4.2.8 Breast Imaging Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	1	1	0	1	3

- **R1:**
  - Explains the difference between diagnostic and screening mammogram. *K*
  - Critiques the technique of mammography and ultrasound and how to differentiate between a good-quality mammogram and suboptimal examination. *K, S*
  - Identifies the cases where additional mammographic images, such as spot magnification or compression views, are needed. *S, A*
  - Carries out ultrasound examination (scanning) of the breast. *S, A*

- Recognizes the indications of breast ultrasound and MRI. *K, S*
- Recognizes all the descriptive BI-RADS lexicon for mammogram and ultrasound. *K, S*
- Generates a good quality report for mammogram and ultrasound as per the latest ACR BI-RADS lexicon. *S, A*
- Formulates and provides appropriate recommendations that match the BI-RADS category. *K, S, A*
- Identifies all the benign and malignant features on mammogram and ultrasound. *K, S*
- Critiques the breast MRI technique and is able to have a logical approach for breast MRI. *S, A*
- Demonstrates a good approach in describing: *K, S*
  - Breast microcalcifications
  - Breast masses
  - Asymmetry spectrum
  - Architectural distortion
  - Complex cystic lesions and intraductal abnormality
  - Mass- and non-mass-like enhancement of breast MRI
- Identifies the common male-related breast diseases. *K, S*
- Recognizes pregnancy-related and lactation-related breast diseases. *K, S*

- **R2-R4:**
  - Recognizes all the descriptive BI-RADS lexicon for mammography, ultrasound, and MRI. *K, S*
  - Generates a good quality report for mammogram, ultrasound, and MRI as per the latest ACR BI-RADS lexicon. *S, A*
  - Identifies all benign and malignant features on mammography, ultrasound, and MRI. *K, S*
  - Demonstrates a good understanding of the indications for stereotactic guided biopsy, ultrasound-guided biopsy, and MRI-guided biopsy. *K, S*

- Demonstrates good understanding of the indications for stereotactic, ultrasound-guided, or MRI-guided wire localization. *K, S*
- Recognizes the definition of multifocal versus multicentric breast diseases. *K, S*
- Recognizes the meaning of radiology-pathology correlation. *K, S*
- Recognizes the meaning of concordant versus discordant radiology-pathology findings. *K, S*
- Describes the steps of performing stereotactic guided, ultrasound guided biopsy. *K, S*
- Describes the steps involved in performing wire localization under ultrasound guidance or stereotactic guidance. *K, S*

Useful reading material: Please refer to Appendix A

4.2.9 Body MRI Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	0	1	1	1	3

- **R2:**
  - Explains how the MR images are obtained and formed (machine, patient preparation and positioning, contrast media). This requires attendance with MRI technologists for a few days in order to: ***K, S, A***
    - Illustrate the MRI machine, how the patient is positioned, and how the images are acquired. *K, S*
    - Recognize and observe the workflow from the technologist perspective. *K, S*
    - Recognize the required patient preparation for the imaging study. *K, S, A*
    - Recognize MRI zones and observe how the technologist obtains consent and screens the patients. *K, S, A*

- Recognize and observe the steps undertaken for contrast media administration, and the safety issues and precautions undertaken by technologists. *K, S*
- Recognize and observe how image protocols are implemented, how different sequences are acquired and optimized, and how the timing of image acquisition after contrast medium administration is performed. *K, S*
- Recognize and observe how image quality control is maintained, how changing imaging parameters can affect image quality, and how image artifacts are recognized and avoided/rectified. *K, S*
- Recognize how technologists adapt examinations for difficult or risky patients' situations. *S, A*
- Recognize and observe how image post-processing is performed, and how images are transferred to PACS. *K, S*

- Describes the basic principles of imaging generation in MRI. *K*
- Recognizes the basic abdominopelvic protocols. *K, S*
- Recognizes the main abdominopelvic MRI sequences and their uses. *K, S*
- Describes the tissue properties in the various sequences. *K, S*
- Identifies anatomy on the various abdominopelvic MRI planes. *K, S*
- Identifies MRI findings of common abdominopelvic pathologies (including pelvic imaging in women), and develop a diagnostic approach to formulate a differential diagnosis. *K, S*

- **R3:**
  - Explains how different MRI sequences are acquired and optimized, and recognize the safety issues and precautions undertaken by technologists (this requires attendance with MRI technologists for a few days). *K, S, A*
  - Selects, with assistance, appropriate protocols for various abdominopelvic MRI examinations. *S, A*
  - Explains the advanced imaging acquisition parameters. *K, S*

- Detects various abdominopelvic MRI artifacts. *K, S*
- Identifies the detailed anatomy of specialized studies such as the prostate, rectum, and perianal region. *K, S*
- Identifies MRI findings of various abdominopelvic pathologies and formulates and ranks the differential diagnosis list. *K, S*
- Correlates MRI findings with other imaging studies, if available, to help narrow the differential diagnosis. *K, S, A*

- **R4:**
  - Selects appropriate protocols for various abdominopelvic MRI indications and prescribe sequences/planes. *S, A*
  - Evaluates and monitors, with assistance, abdominopelvic MRI protocols, and indicates when additional sequences/planes are needed. *S, A*
  - Detects various MR artifacts and describes methods to rectify them. *S, A*
  - Identifies MRI findings of various abdominopelvic pathologies, formulates and ranks a narrow differential diagnosis list, and judges what is the most likely diagnosis. *K, S*
  - Correlates MRI findings with clinical picture, laboratory findings, and other imaging studies, if available, to help narrow the differential diagnosis and reach the most likely diagnosis. *K, S, A*

Useful reading material: Please refer to Appendix A

4.2.10 Fluoroscopy & Plain Films Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	1	0	1	0	2

- **R1:**
  - Explains how X-ray images are obtained and formed. This requires attendance with X-ray technologists for a few days in order to: *K, S, A*

- Illustrate the X-ray machine, how the patient is positioned, and how the images are acquired. *K, S*
- Recognize and observe the workflow from the technologist's perspective. *K, S*
- Recognize the required patient preparation for the imaging study. *K, S, A*
- Recognize and observe how technologist obtains the consent of patients. *K, S, A*
- Recognize and observe procedures undertaken for radiation dose reduction and protection. *K, S*
- Recognize and observe image protocols. *K, S*
- Recognize and observe how image quality control is maintained, how changing imaging parameters can affect image quality, and how image artifacts are recognized and avoided/rectified. *K, S*
- Recognize how technologists adapt examinations for difficult or risky patients' situations. *S, A*
- Recognize and observe how image post-processing is performed, and how images are transferred to PACS. *K, S*

- Recognizes the normal and variant anatomy on radiographs and fluoroscopy. *K, S*
- Recognizes the indications, contraindications, patient positioning, and needed views for various X-ray and fluoroscopic procedures. *K, S, A*
- Recognizes when and how to use different types of contrast media, for example, single/double barium, high, and low osmolar contrast media. *K, S*
- Carries out, under supervision, routine fluoroscopic examinations. *S, A*
- Recognizes different lines and tubes seen on radiographs and detects their complications and displacement. *K, S*
- Recognizes basic pathologies and formulates proper differential diagnoses. *S, A*

- **R3:**
  - Carries out advanced fluoroscopic techniques and examination of difficult patients. *S, A*
  - Recognizes unusual and common appearances of common pathologies on radiographs and fluoroscopy with their differential diagnoses. *K, S*
  - Recommends the most appropriate next appropriate step. *S, A*

Useful reading material: Please refer to Appendix A

4.2.11 Emergency Radiology / Plain Films Rotation

Number of Rotations	R1	R2	R3	R4	TOTAL
	1	0	0	0	1

Reading plain films and emergency imaging studies are often covered by different sections in the radiology department, which may create a gap in training. This rotation fills this gap, allowing the training center/program director to tailor the rotation according to the training center needs. The training center/program director can assign the resident in this rotation to read plain films (ER/inpatient plain films, outpatient plain films, or combinations), or assign him/her for reading emergency cross-sectional imaging (this can be done in routine daily work or can be done through a night-float-call system, and for adult or pediatric patients). Therefore, the objectives of the rotation depend on the type of work assigned to the resident. The following objectives are intended to cover different scenarios of this rotation.

- Plain Films:
  - Recognizes the normal and variant anatomy on radiographs. *K, S*

- Recognizes the most frequent indications for standard radiographic imaging. *K*
- Recognizes the indications, contraindications, patient positioning (requires attendance with radiographers), and needed views for radiographic imaging. *K, S, A*
- Recognizes different lines and tubes seen on radiographs and learn to detect their complications and displacement. *K, S*
- Interprets and recognizes basic pathologies. *K, S*

- Emergency Radiology (ER):
  - Recognizes the appropriate indications and contraindications for various ER cross-sectional imaging. *K, S*
  - Selects the appropriate protocol for ER and inpatient CT and US studies. *K, S, A*
  - Interprets ER and inpatient cross-sectional imaging (mostly CT scan and US studies): *S, A*
    - Identifies urgent and semi-urgent imaging findings. *S*
    - Formulates and prioritizes differential diagnosis list. *S*
    - Obtains appropriate clinical information. *S, A*
    - Recommends next appropriate step. *S, A*
  - Identifies and manages reactions to contrast media. *K, S, A*

If a night-float-call system is adopted for this rotation, please refer to "On-Call Duties" under Section XIII (Policies and Procedures) for further details of the objectives.

Useful reading material: Please refer to Appendix A

4.2.12 Interventional Radiology Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	0	0	2*	1	3

*Preferably two rotations back-to-back

- **R3-R4:**
  - Recognizes vascular and relevant non-vascular anatomy. *K, S*
  - Describes general aspects of vascular and non-vascular interventional procedures, including indications, contraindications, complications, contrast media implications, and radiation protection. *K, S*
  - Recognizes protocols and indications and appropriate applications for CT scan and US vascular imaging, as well as aspects of radiation protection related to CT scan. *K, S*
  - Describes the risks involved in common interventional techniques and their management. *K, S, A*
  - Recognizes pharmacology, medication administration, and patient supervision in relation to intraprocedural medications, including sedatives and analgesics. *K, S, A*
  - Recognizes emergency conditions and their appropriate management. *K, S, A*
  - Carries out basic arterial and venous catheterization, angiograms, and basic non-vascular interventions such as drainage, FNA, and biopsy. *S, A*
  - Practices and assists in complex procedures such as embolization and angioplasty (including neurointerventional procedures). *S, A*
  - Uses catheters and wires, and recognizes the basic catheter types. *K, S*
  - Demonstrates the ability to manage patients undergoing interventional procedures and recognizes acceptable and expected results of interventional procedures and appropriate post-procedural care and follow-up. *S, A*
  - Discusses, reviews, and reads about the procedures scheduled on the next day. *S, A*

- Practices and participates in dedicated interventional radiology clinics and in assessment and care of inpatients pre- and post-interventional procedures. *S, A*
- Interprets vascular imaging studies. *K, S*
- Generates complete well-structured procedural reports. *S*

Useful reading material: Please refer to Appendix A

4.2.13 Cardiac Imaging Rotation

Number of Rotations	R1	R2	R3	R4	TOTAL
	0	0	1	0	1

- Recognizes cardiovascular anatomy and normal variations on CT, MRI, and X-ray. *K, S*
- Describes the imaging features and basic clinical features of acquired cardiovascular diseases of the coronary arteries, myocardium, pericardium, endocardium, and heart valves. This includes, but is not limited to, the following: *K, S*
  - Acute coronary syndromes
  - Myocardial ischemia
  - Myocardial infarction
  - Post-myocardial infarction syndromes
  - Ventricular aneurysms
  - Arteritis
  - Cardiac tumors
  - Cardiomyopathy, including acute myocarditis
  - Dilated cardiomyopathy
  - Restrictive and obstructive cardiomyopathy
  - Cardiomyopathy related to systemic disease
  - Infiltrative cardiomyopathy

- Sudden-death syndromes in young patients and athlete's heart

- Describes the imaging features and basic clinical features of adult CHD. *K, S*
- Describes the principles and techniques of coronary calcification scoring (calcium scoring) and recognizes the limitations of coronary calcification scoring and its epidemiological implications. *K, S*
- Describes the imaging features and basic clinical features of diseases of the major vessels, including thoracic aneurysms, acute and chronic aortic dissection, Marfan's syndrome, and Takayasu's disease. *K, S*
- Recognizes indications and contraindications for cardiac CT scans and MRI. *K, S*
- Plans and prepares patients for cardiac CT scan, including verification of indications, venous access, and beta-blocker therapy. *S, A*
- Selects optimal acquisition parameters for cardiac CT scan. *K, S*
- Selects optimal post-processing tools for cardiac CT scan. *K, S*
- Recognizes the mean exposure doses for CT scan examinations. *K*
- Plans and prepares patients for cardiac MRI, including verification of indications, venous access, and medication (e.g., stress tests). *S, A*
- Selects optimal acquisition parameters for cardiac MRI. K, S
- Selects optimal post-processing tools for cardiac MRI. *K, S*
- Applies ECG gating for cardiac CT scan and MRI. *S, A*
- Determines the optimal timing for contrast bolus administration during cardiac CT and MRI. *S*
- Carries out coronary calcification scoring. *S*
- Independently performs post-processing tasks for cardiac and vascular imaging studies, including multiplanar reformation (MPR), maximum intensity projection (MIP), minimum intensity projection (MinIP), volume rendering tools (VRT), and vessel analysis tools. *S, A*
- Interprets CT scan and MR of the heart, coronary arteries, and thoracic aorta. *S*

Useful reading material: Please refer to Appendix A

4.2.14 Research/QI Rotation

Number of Rotations	R1	R2	R3	R4	TOTAL
	0	0	1	0	1

This rotation gives the resident, under faculty supervision, an opportunity to either:

- conduct a research project, with the aim of producing publishable material,
- or undertake a departmental quality improvement (QI) project to help improve the patient's care, increase efficiency of workflow, or prevent/minimize errors.

It is expected that the project will span more than a month. Therefore, the resident is advised to select a supervisor and a research topic before starting the rotation, finish the bulk of the project during the rotation, and complete it while performing subsequent radiology rotations.

Research Project:

- Develops familiarity with research study types and their advantages and disadvantages from the perspective of radiology. *K, S*
- Demonstrates the ability to ask research questions and design appropriate research methods to answer these questions. *K, S*
- Practices appropriate literature search and assesses the existing body of literature relevant to the study topic. *K, S*
- Carries out a research proposal. *S*
- Recognizes and adheres to the ethical requirements of research. *K, S, A*

- Practices appropriate methods to conduct a research study, including data collection, data analysis, discussion of study results, withdrawal of conclusions, and addressing limitations. *S*
- Practices the essential skills for writing scientific manuscript drafts. *S*
- Presents research project at the Annual Research Day or journal club (or conferences), to acquire the skills for scientific presentations and public discussions. *S, A*

QI Project:

- Describes QI terminology and the tools and steps for improving the quality of technical and clinical performance in a radiology department. For example: Key performance indicators (KPIs) and Plan-Do-Study-Act (PDSA) cycle. *K*
- Develops familiarity with the workflow of the radiology department and other departments (surgery, medicine, and emergency medicine) and quality assurance (QA) systems and ensures that they participate in the hospital's QI activities. *K, S*
- Applies audit procedures, including problem identification, action planning, and reassessment. *K, S*
- Develops familiarity with the tools used to manage the quality of radiology services. *K, S*
- Describes how performance improvement relates to patient safety in radiology. *K, S*
- Recognizes opportunities for improvement in the radiology department's functions. *S*
- Carries out a complete mentored QI project. *S*
- Presents QI project at the Annual Research Day, department QI rounds, or journal club to acquire skills for scientific presentations and public discussions. *S, A*

- Practices and participates in departmental and hospital QI activities by attending committee meetings. *S, A*
- Practices and participates in hospital QA committee and departmental morbidity and mortality (M and M) meetings. *S, A*

Examples of QI projects:

- Accuracy of Interpretation (Double Reading)
- Root cause analysis of interpretation errors in abdominal CT scans
- Analysis of misses in oncological follow-up CT scans
- Reporting Timeliness (Reporting Turnaround Time)
- Communication of critical radiology results
- Safe use of intravenous iodinated contrast material
- Management of intravenous contrast adverse effects
- Reduction of the incidence and risk of contrast nephropathy
- Radiation safety
- MRI safety
- Evaluation of incident reporting in radiology
- The ACR's Appropriateness Criteria
- Appropriateness of studies ordered from the emergency department
- Improving patients waiting time.

Useful reading material: Please refer to Appendix A

4.2.15 Elective Rotations

Number of Rotations	R1	R2	R3	R4	TOTAL
	0	0	1	2	3

As the residents advance to senior levels (R3 and R4), advance along a planned course of graded responsibility, and gradually assume semi-independent reporting under staff supervision, they are given the opportunity to fill any gaps in training via elective rotations. In such elective rotations, the residents can tailor their rotation design to include those areas that best suit

their personal learning objectives and future career directions. One of these three elective rotations (either in R3 or R4), MUST be one of the following (must be in a center accredited by SCFHS for such training service):

- Obstetric Ultrasound
- Vascular Imaging
- Head and Neck Imaging

After the approval of the program director, any of the core rotations can be chosen by the resident, except for the following rotations: Fluoroscopy & Plain films, Emergency Radiology / Plain Films, Research/QI, and Core Skills.

If desired, one elective can be used to attend a 4-week radiology/pathology course at the American Institute of Radiologic Pathology (AIRP), which is conducted in the USA under the auspices of the American College of Radiology. If desired, the AIRP course can replace any of the three elective blocks mentioned above (Obstetric Ultrasound, Vascular Imaging, and Head and Neck Imaging).

The following is an outline of the objectives of the three rotations mentioned above (Obstetric Ultrasound, Vascular Imaging, and Head and Neck Imaging)

Obstetric Ultrasound

- Ultrasound in the first trimester:
  - Carries out ultrasound scanning and recognizes gestational sac, including intra-uterine location, yolk sac, amnion, and fetal cardiac activity. *S, A*
  - Recognizes criteria for a definite diagnosis of fetal death in the first trimester. *K, S*
  - Identifies subchorionic hematoma. *S*
  - Recognizes sonographic features of molar pregnancy. *K, S*
  - Recognizes and diagnose ectopic pregnancy. *K, S*

- Recognizes sonographic features of major fetal anomalies and malformations during early pregnancy. *K, S*

- Evaluation of the second and third trimester ultrasound examination:
  - Scans and assesses fetal biometry with sonographic dating during the second and third trimesters. *K, S*
  - Identifies placental localization. *K, S*
  - Identifies sonographic appearance of placenta previa and low-lying placenta. *K, S*
  - Identifies possibility of placenta accreta and its spectrum. *K, S*
  - Assesses amniotic fluid for oligohydramnious and polyhydramnios. *K, S*
  - Assesses cervical length during second and third trimester. *K, S*
  - Assesses twin pregnancy (understanding of chorionicity and amnionicity in multifetal pregnancy). *K, S*
  - Recognizes normal fetal head anatomy and head common anomalies. *K, S*
  - Assesses the facial anatomy and common malformations. *K, S*
  - Assesses fetal thoracic anatomy and common malformations. *K, S*
  - Assesses fetal heart anatomy and common malformations. *K, S*
  - Assesses the normal fetal abdominal anatomy and common malformations. *K, S*
  - Identifies normal fetal pelvic anatomy and common malformations. *K, S*
  - Identifies normal fetal skeletal anomaly and common malformations. *K, S*
- Carries out ultrasound scanning and recognizes the following: *S*
  - Mean sac diameter
  - Crown-rump length
  - Fetal presentation
  - Fetal extremities
  - Biparietal diameter

- Head circumference
- Abdominal circumference
- Femur diaphysis length
- Biophysical profile
- Amniotic fluid index
- Cervical length in transabdominal and transvaginal assessment
- Face assessment with visualization of the upper lip
- Four-chamber view
- Left ventricular outflow tract
- Right ventricular outflow tract
- Abdominal circumference level
- Cord insertion, number of cord vessels
- Urinary bladder and kidneys
- Stomach situs
- Longitudinal image of the spine
- Axial image of the spine
- Assessment of the 4 limbs

Useful reading material: Please refer to Appendix A

Vascular Imaging

- Describes the strengths, limitations, indications, and contraindications of each imaging modality in assessing vascular disease (ultrasound, CT scan, MRI, and angiography). Examples of such studies include carotid artery Doppler US, venous insufficiency Doppler US, peripheral vascular disease imaging, aortic aneurysm repair imaging, pre-transthoracic aortic valve repair imaging, renovascular disease imaging, and deep epigastric perforator flap planning CT angiography. *K, S*
- Justifies choosing specific examinations for specific clinical scenarios. *K, S, A*

- Selects an appropriate imaging protocol and image reconstruction for various clinical scenarios. *S, A*
- Recognizes vascular and relevant anatomical variants and non-vascular anatomy in vascular imaging studies. *K, S*
- Interprets various vascular imaging studies, identifies abnormalities, correlates with other imaging studies and clinical information whenever appropriate, formulates a differential diagnosis list and provides a likely diagnosis, and recommends and discusses the most appropriate next step in patient management. *S, A*
- Generates and reports appropriate quantitative measurements to guide subsequent management. *S*
- Utilizes appropriate lexicon and phrases to describe vascular imaging findings in various modalities. *K, S*

Useful reading material: Please refer to Appendix A

Head and Neck Imaging

- Recognizes detailed CT scan and MRI imaging anatomy of the paranasal sinuses, orbits, skull base, temporal bones, and neck. *K, S*
- Demonstrates knowledge of MRI and CT scan protocols, techniques, and physics. *K, S*
- Appropriately selects different CT and MRI imaging protocols for various clinical indications. *S, A*
- Evaluates and optimizes image quality, including dose reduction strategies. *S, A*
- Formulates and prioritizes differential diagnosis list for head and neck diseases. *S*
- Identifies imaging findings on both CT and MRI, and formulate and prioritize the differential diagnosis list for head and neck diseases. *S*
- Chooses and provides a single diagnosis, when possible, and integrates current guidelines for appropriate recommendations. *S, A*

Useful reading material: **Please refer to Appendix A**

4.2.16 Core Skills Rotation

Number of Rotations	R1	R2	R3	R4	TOTAL
	1	0	0	0	1

This rotation contains a 2-week radiologic physics course, in addition to other important and essential skills that may not be formally addressed in clinical rotations yet warrant further training. Such skills include management of common on-call scenarios (emergency radiology course), familiarity with concepts and competencies of CanMEDS roles in radiology, radiology reporting skills, interpersonal and communication skills, imaging informatics, artificial intelligence and teleradiology, contrast media management, research basics, basics of quality and safety in radiology, and presentation skills. If time permits, additional skills can be taught during this rotation if deemed beneficial by the training program or the Diagnostic Radiology Scientific Council.

All R1 radiology residents in one region (or nationally, if applicable) will have this rotation at the same time (preferably in block 5, 6, 7, or 8). The Diagnostic Radiology Scientific Council at SCFHS (in coordination with program directors of all regions) will be responsible for planning and preparing/supervising the scientific content of this rotation. Resident attendance of all activities of this rotation is mandatory.

The following table shows a suggested distribution of this rotation's activities (please note that this table is just for demonstration purposes, and the contents and their distribution are subject to change at any time).

		Sunday	Monday	Tuesday	Wednesday	Thursday
1st Week	Morning	Physics Course				
	Afternoon					
2nd Week	Morning	Physics Course		Academic Half-Day	Emergency Radiology Course	
	Afternoon					
3rd Week	Morning	CanMEDS Roles in Radiology	Radiology Reporting Skills	Academic Half-Day	Imaging Informatics, AI & Teleradiology	Contrast Media Management
	Afternoon			Communications Skills	Local Center activity/workshop	
4th Week	Morning	Research Basics	QI Basics	Academic Half-Day	Lecture Presentation Skills	Local Center activity/workshop
	Afternoon		Safety in Radiology	Radiation Safety	Local Center activity/workshop	Local Center activity/workshop

Below is an outline of the learning objectives of these activities.

Radiologic Physics Course:

- Describe basic radiation physics, including atomic structure and physics, electromagnetic radiation, and particulate radiation.
- Describe ionizing radiation interactions with matter.
- Describe radiation units, and discuss the appropriate use of various radiation metrics.
- Describe X-ray production and output, and how changing the X-ray tube design, technique factors, or X-ray beam modification techniques affects the resultant images and can be optimized for a specific imaging task.

- Explain the underlying physics and technology concepts of X-ray – Projection imaging:
    - Describe radiographic imaging system components and how variations in system configuration and geometric features affect the images.
    - Describe differences between radiographic detector types, how images are detected and processed by different detector types, and how they influence image quality and dose.
    - Describe radiographic image quality parameters and identify common artifacts and how they can be mitigated.
    - Identify factors that affect the patient's dose and describe the proper use of automatic exposure control (AEC).
- Explain underlying physics and technology concepts unique to mammography:
    - Describe components of breast imaging systems (digital mammography, stereotactic biopsy system, tomosynthesis), and describe the physics principles and features unique to breast imaging systems.
    - Describe acquisition techniques, selection of acquisition parameters, display requirements, common artifacts, and how they can be mitigated.
    - Discuss breast radiation dosimetry and factors that affect radiation dose.
- Explain underlying physics and technology concepts unique to fluoroscopy and interventional imaging:
    - Describe the components of fluoroscopic systems and explain how variations in system configuration and geometric features affect the resultant images.
    - Describe differences between detector types used in fluoroscopic systems.

- Describe different operating modes, and image processing and storage used in fluoroscopic systems.
- Describe factors that affect image quality in a fluoroscopic system, how to optimize the images, recognize common artifacts, and rectify them.
- Describe factors that affect patient dose during a fluoroscopic or interventional procedure, describe various radiation dose indicators, and describe methods to minimize radiation dose to the patient and staff.

- Explain underlying physics and technology concepts unique to CT scan:
  - Describe components and types of CT scan systems.
  - Describe how the CT images are processed and formed, and describe various image acquisition modes, image acquisition parameters, and image reconstruction options, and how they affect the resultant images.
  - Describe how image acquisition parameters affect image quality and radiation dose.
  - Compare CT image characteristics (e.g., spatial resolution, contrast resolution) with those of other imaging modalities.
  - Describe sources of common CT images artifacts and how to mitigate them.
  - Describe various CT dose metrics and their limitations and recognize typical dose values for common examinations and how they can be minimized and optimized (image quality/dose tradeoff).
- Explain underlying physics and technology concepts of ultrasound:
  - Describe the underlying physics of sound wave properties, ultrasound interactions with matter, and ultrasound image production.
  - Describe components of ultrasound systems.
  - Describe the design and types of ultrasound transducers and describe the principles of beam formation.

- Describe how transducer design/type and acquisition parameters influence image quality.
- Describe the appropriate clinical applications of various transducer types.
- Describe modes and appropriate use of Doppler ultrasound.
- Describe how to adjust scanning parameters to optimize image quality.
- Discuss advanced ultrasound technologies (e.g., harmonic imaging, extended field of view, 3D/4D imaging, and elastography).
- Describe common ultrasound images artifacts, underlying causes, and how to mitigate them.
- Discuss bioeffects of ultrasound.

- Explain underlying physics and technology concepts of MRI:
  - Describe underlying physics of magnetism, and how materials react to magnetic fields.
  - Describe MR system components and their functions.
  - Describe MR signal properties, how the MR signal is created, how the spatial localization of the signal is achieved, and how the image is formed.
  - Describe and compare parameters, types, contrast mechanisms, and applications of various MR pulse sequences (basic and fast imaging techniques).
  - Describe types of MR contrast agents and how they affect MR signals.
  - Discuss the basic concepts of special acquisition techniques, such as diffusion, perfusion, and flow imaging.
  - Describe how image acquisition parameters affect image quality, acquisition time, and tradeoff between different study quality metrics.
  - Describe how different field strength systems influence acquisition parameters and image quality.
  - Describe common MRI artifacts, underlying causes, and how to mitigate them.

- Describe safety issues, bioeffects, and contraindications of MRI.

- Explain underlying physics and technology concepts of nuclear medicine:
  - Describe radionuclide decay modes and resultant emissions
  - Describe methods of radioisotope production, and discuss characteristics of common radionuclides, and kinetics of commonly used radiopharmaceuticals
  - Describe system components, operation characteristics, image acquisition/formation, and quality control for scintillation cameras, single photon emission computed tomography (SPECT), and positron emission tomography (PET) scanners.
  - Describe how image acquisition parameters affects image quality in nuclear medicine imaging.
  - Describe common NM artifacts, underlying causes, and how to mitigate them.
  - Describe safety issues and radiation protection in NM.
  - Describe various radiation detectors used for measurement and calibration of radioactivity.
- Explain biological effects of ionizing radiation:
  - Describe radiobiology, how radiation deposits energy and causes biological effects, what factors impact cell radiosensitivity, and compare the radiosensitivities of different organs.
  - Discuss the deterministic effects of radiation and its thresholds.
  - Discuss the risk of stochastic effects of radiation.
  - Discuss the effect of radiation on mutagenesis and teratogenesis, and discuss the probable radiation effects and radiosensitivity of the fetus at different ages of pregnancy.
  - Discuss radiation risks and different dose-response models for radiation effects, and compare and communicate the benefits and risks of radiological study.
  - Discuss related applied radiology, for example, counseling a pregnant woman on the potential radiation risks to the fetus, illustrate the risks

and deterministic effects of high-dose fluoroscopy, and how to apply radiation protection principles to mitigate such risks.

- Explain principles of radiation protection and associated regulations:
  - Identify sources of radiation (background, medical, occupational).
  - Discuss tracking and monitoring of patients' radiation doses and recognize permissible dose limits to the public.
  - Discuss methods used to monitor occupational exposure (personal dosimeters, area monitors) and recognize permissible dose limits for radiation workers.
  - Explain principles of radiation protection (time, distance, shielding, contamination control, ALARA, procedure appropriateness)
  - Discuss radiation safety issues pertinent to radioactive materials (e.g., radioactive spills, radioactive waste management, release criteria for patients who received a radioactive material, instructions to breast-feeding woman who received a radioactive material, pregnant woman seated next to a patient who received a radioactive material).
- Test problem-solving skills using RAPHEX-type examinations.

Useful reading material: Please refer to Appendix A

Emergency Radiology Course:

Training centers are encouraged to implement their own emergency radiology preparatory courses for their residents during earlier blocks before starting the calls. This course is intended to serve as a refresher, with the following learning objectives in mind:

- Develop essential skills for interpretation, proper imaging/protocol selection, and management of common on-call scenarios.
- Recognize, interpret, and protocol common imaging on-call scenarios in neuroradiology (e.g., acute infarcts, skull and facial fractures, extra-axial hemorrhage, parenchymal injuries, subarachnoid hemorrhage, non-

traumatic hemorrhage, vascular injuries, dural sinus thrombosis, brain edema, herniation syndromes, acute central nervous system infections, acute face and neck infections, spinal trauma, cord compression, spinal infection, and skull fractures).

- Recognize, interpret, and protocol common on-call scenarios in thoracic imaging (e.g., thoracic traumatic injuries, pulmonary embolism, aortic dissection and other acute vascular pathologies, acute pulmonary infections, pulmonary edema, acute respiratory distress syndrome, esophageal rupture, tubes, and lines).
- Recognize, interpret, and protocol common imaging on-call scenarios in abdominal imaging (e.g., abdominal traumatic injuries, appendicitis, bowel perforation, bowel ischemia, gastrointestinal hemorrhage, enteritis and colitis, diverticulitis, intraabdominal focal fat infarction, cholecystitis, jaundice, pancreatitis, urolithiasis, hydronephrosis, urinary tract infection, peritonitis, ascites, abdominal abscess, non-traumatic intraabdominal hemorrhage, testicular torsion/infection/trauma, ovarian torsion, ectopic pregnancy, tubes and lines).
- Recognize, interpret, and protocol common imaging on-call scenarios in MSK imaging (e.g., unstable fractures, particularly spine fractures, septic arthritis, osteomyelitis, and necrotizing fasciitis).
- Recognize, interpret, and protocol common imaging on-call scenarios in pediatric imaging (e.g., intussusception, fractures, child abuse, pneumonia, epiglottitis, retropharyngeal abscess, foreign body aspiration).

Useful reading material: Please refer to Appendix A

CanMEDS Roles in Radiology:

- Define the CanMEDS roles.
- Discuss key concepts and competencies for each CanMEDS role.
- Apply these concepts and competencies to radiology scenarios.

Useful reading material: Please refer to Appendix A

Radiology Reporting Skills:

- Recognize the importance and purposes of radiology reports.
- Recognize the essential qualities of a good clinically-oriented radiology report.
- Recognize advantages and disadvantages of different reporting styles (narrative versus structured reporting).
- Recognize the basic components of the radiology report.
- Recognize the common flaws in radiology reports.
- Recognize the difference between preliminary reports and a final radiology report.
- Recognize the importance of timely communication with the caring physician, and explain when the caring physician must be contacted and how communication is documented.
- Discuss the definition, levels, methods, documentation, and impact of critical results notification.
- Recognize the concept of closed-loop communication.
- Demonstrate the ability to produce good-quality (accurate, clear, concise, complete, clinically oriented, and actionable) reports for different radiology modalities, in accordance with guidelines, and utilizing appropriate lexicons.
- Discuss and critique real-life radiology reports, and practice editing and correcting them to improve their quality.

Useful reading material: Please refer to Appendix A

Interpersonal and Communication Skills in Radiology:

- Recognize the importance of effective communication skills to foster a good relationship between the radiologist and the patients, doctors, and other healthcare workers.

- Recognize the essential elements of communication.
- Discuss and practice communication skills in scenarios commonly encountered in radiology.

Useful reading material: Please refer to Appendix A

Imaging Informatics, Artificial Intelligence, and Teleradiology:

- Discuss the workflow cycle of medical imaging studies and recognize the healthcare and radiologic information systems involved.
- Discuss the technical standards that enable the interoperability of the various systems involved in the radiology workflow cycle.
- Discuss the radiologist reading room environment (basic image display requirements, workstation ergonomics, reporting tools, post-processing applications, post-reporting applications (e.g., data mining, critical result notification)).
- Discuss data privacy and security in radiology.
- Discuss the definition, components, benefits, and common metrics of business intelligence (business analytics) in radiology.
- Discuss the definition, goals, advantages, and disadvantages of teleradiology.
- Discuss definition, terminology, applications, and potential negatives of artificial intelligence (AI).

Useful reading material: Please refer to Appendix A

Contrast Media Management:

- Recognize various contrast media used in radiological studies (type, dose, concentration, dynamics, effect of contrast timing and rate of injection, route of administration).
- Recognize the indications, contraindications, and complications of various contrast media.

- Recognize how to conduct proper screening (relevant history and laboratory results) before contrast media administration to identify contraindications or risk factors for adverse events, weigh risks and benefits, appropriately prepare/premedicate the patient if needed, and be prepared to manage adverse reactions should one occur.
- Recognize safety issues and use of contrast media in pregnant or potentially pregnant patients. Demonstrate the ability to discuss possible risks to the fetus and benefits of the procedure with the patient and referring clinician.
- Recognize safety issues and use of contrast media in women who are breastfeeding.
- Discuss various reactions to contrast media (frequency, severity, risk factors, and premedication).
- Explain how to recognize, assess, and treat contrast media reactions (allergic-like or physiologic reactions).
- Recognize essential emergency equipment/medications needed to manage patients who develop contrast reactions.
- Discuss how to counsel patients who developed adverse effects about future contrast media administration and the possible need for future premedication.
- Explain how to evaluate and manage patients who undergo intravenous contrast media extravasation.
- Recognize the importance of documenting any clinically significant event and its treatment.
- Identify patients at potential risk of contrast-associated acute kidney injury (CA-AKI) and explain how to handle requests for contrast-enhanced study for such patients.
- Discuss contrast media issues in pediatric patients (utilization, adverse effects, premedication, and management of acute reactions).
- Recognize issues unique to gadolinium-based contrast agents (e.g., nephrogenic systemic fibrosis and gadolinium deposition in the brain).

- Recognize miscellaneous issues pertinent to the use of intravascular contrast media (e.g., fasting before contrast media administration, when and for how long metformin should be withheld).
- Discussion indications, contraindications, and adverse reactions pertinent to contrast media used to assess the gastrointestinal system
- Recognize the importance of following facility/imaging department policies, protocols, and procedures pertinent to the administration of intravascular contrast media.
- Discuss controversies and misconceptions on contrast media.

Useful reading material: Please refer to Appendix A

Research Basics:

- Recognize the importance of evidence-based radiology.
- Describe the anatomy of research project.
- Describe types of data.
- Explain descriptive statistics.
- Discuss probability.
- Explain inferential statistics.
- Explain common statistical tests.
- Explain measures of diagnostic reliability.
- Explain measures of reliability and agreement.
- Discuss bias in diagnostic tests.
- Discuss types of studies.
- Recognize research ethics.

Useful reading material: Please refer to Appendix A

Quality Improvement Basics:

- Discuss terminology, definition, importance, and levels of quality in radiology.

- Discuss the domains of quality improvement in radiology using the Donabedian model (structure, process, and outcome).
- Discuss the six aims of high-quality care (safe, effective, patient-centered, timely, efficient, and equitable) proposed by the 2001 Institute of Medicine (IOM) report Crossing the Quality Chasm, and explain how they relate to radiology (Committee on Quality of Health Care in America; for the Institute of Medicine. Crossing the quality chasm: A new health system for the 21st century. Washington DC: National Academy Press, 2001).
- Discuss the just culture system and how different types of errors are handled in such a system.
- Discuss commonly used tools in quality improvement activity.
- Discuss the American College of Radiology's Imaging 3.0 initiative.

Useful reading material: Please refer to Appendix A

Safety in Radiology:

- Discuss the definition, rate, impact, and causes of medical errors.
- Discuss the definition of diagnostic error.
- Discuss the types of diagnostic errors and biases in radiology and discuss strategies to counteract them.
- Discuss patients' safety issues pertinent to radiology (universal protocol, MRI safety, intravascular contrast media safety, radiation safety, imaging pregnant and lactating patients, improving radiologists' communication, critical results notification, and improving the appropriateness of imaging utilization).
- Discuss the "Never Events" in Radiology and strategies to reduce preventable serious adverse events.
- Discuss the definition, levels, methods, documentation, and impact of critical results notification.
- Discuss safety issues pertinent to radiology staff.

- Recognize initiatives dedicated to improving standards of practice and safety in radiology, such as "Image Wisely," "Image Gently," and "Step Lightly."

Useful reading material: Please refer to Appendix A

Radiation Safety:

- Discuss and compare the radiation doses to patients and staff of various radiologic procedures.
- Discuss radiation cancer risk and how it differs with patients' age and gender.
- Explain the ALARA principle and the concepts of justification and optimization when dealing with radiology examinations.
- Explain the basic protective measures of radiation safety (time, distance, and shielding).
- Recognize initiatives dedicated to improving standards of practice and safety in radiology, like "ACR Appropriateness Criteria," "Image Wisely," "Image Gently," and "Step Lightly."
- Discuss strategies to reduce CT scan radiation dose, for example, actions at the ordering stage (justification, avoiding duplicate exams, offering alternative exams with lower dose or no radiation), actions at exam time (exam optimization: proper protocol, proper patient positioning, limit imaging to the area of interest), actions at the stage of exam reporting (using proper imaging follow-up guidelines, considering follow-up with US or MRI, if appropriate, for young patients), and actions at the departmental level (equipment optimization, protocol optimization and pre-loading on scanners, using automatic exposure control, periodic quality improvement, and dose monitoring).
- Discuss strategies to reduce radiation dose in fluoroscopic procedures.

- Discuss the differences between pediatric and adult patients with regard to radiation exposure and potential stochastic risks, and discuss strategies to reduce radiation dose in pediatric patients.
- Discuss radiation safety in pregnant or potentially pregnant women (potential radiation effects to the conceptus, indications for pregnancy screening, consenting, optimizing imaging, counseling a patient who was discovered to be pregnant only after being exposed to radiation.
- Discuss how to communicate radiation risks (and risks of not performing the exam) to the patients and their families, and to other physicians.

Useful reading material: Please refer to Appendix A

Lecture Presentation Skills:

- Discuss how to construct successful and engaging oral presentation.
- Discuss factors affecting how to choose and design the presentation content.
- Discuss basic principles of speaking to ensure effective delivery of information.
- Discuss how to design and organize presentation slides.
- Discuss how to use, design, and describe radiologic images.
- Discuss factors that keeps audience engaged.

Useful reading material: Please refer to Appendix A

IX. CONTINUUM OF LEARNING

The developmental journey of diagnostic radiology trainees passes through different stages (milestones) along the competency continuum. Trainees throughout their learning journey, from junior and throughout senior levels, will be assisted in transforming from (novice/supervised) to (master/unsupervised) practitioners. However, it must be emphasized that the trainees, as adult learners, carry the primary responsibility of life-long continuous professional development (CPD). Trainees should keep in mind the necessity of CPD for every healthcare provider in order to meet the demands of their vital profession.

The following table shows how the role is progressively expected to develop throughout the junior, senior, and consultant levels of practice.

Undergraduate	R1 - R2 (Junior Level)	R3 - R4 (Senior Level)	Consultant
Non-practicing	Dependent/supervised practice	Dependent/supervised practice	Independent practice/provide supervision
Obtain basic health science and foundational-level to core discipline knowledge	Obtain fundamental knowledge related to core clinical problems in radiology	Apply knowledge to provide appropriate clinical care related to core clinical problems in radiology	Acquire advanced and up-to-date knowledge related to core clinical problems in radiology
Internship to the practice of discipline	Recognize and interpret imaging findings from different imaging modalities related to the core clinical problems in radiology, develop appropriate differential	Analyze and interpret more complex imaging findings from different imaging modalities and incorporate them with clinical information, to develop appropriate	Compare and evaluate challenging, complex findings and develop rational differential diagnoses and

Undergraduate	R1 - R2 (Junior Level)	R3 - R4 (Senior Level)	Consultant
	diagnoses, and with help formulate recommendations	differential diagnoses and management plan for the patient	management plan tailored to individual patient

X. TEACHING METHODS

The teaching process in postgraduate training programs is based mainly on the principles of adult learning theory. The trainees feel the importance of learning and of taking an active role in the content and process of their own learning. The training programs implement the adult learning concept on each feature of the activities where the residents are responsible for their own learning requirements. Formal training time includes the following three formal teaching activities:

- Program-Specific Learning Activities
- Universal Topics
- General Learning Opportunities

1.Program-Specific Learning Activities

Program-specific activities are educational activities that are specifically designed and intended for trainees' teaching during their training time. The trainees are required to attend these activities, even if they are at outside rotations with a protective time for them. Attendance and participation in these activities will be incorporated into an annual assessment tool score. Program administration should support these activities by providing protected-time for trainees to attend these activities and allow them to participate in such activities.

1.1 Program Academic Half-Day

A weekly half-day (at least 2–4 hours) is reserved for this activity. It comprises planned sessions/lectures with assigned tutors, time slots, and venues (or virtual). It is recommended that lectures be conducted in an

interactive, case-based discussion format. The academic half-day covers the core radiology topics that are determined and approved by the scientific council and aligned with specialty-defined competencies and teaching methods to ensure that important clinical problems of the specialty are well taught. Topics such as radiation protection, critical appraisal, and quality-related issues can be included in the academic half-days as well.

The recommended number of half-days conducted annually is 30–40 sessions per training academic year. The residency training committee, program directors, and chief residents in coordination with academic and training affairs and regional supervisory committees should work together to ensure the planning and implementation of academic activities as indicated in the curriculum. The learning objectives of each core topic need to be clearly defined, and it is preferable to use pre-learning material. Whenever applicable, core specialty topics can be presented in workshops, team-based learning (TBL), and simulation to develop skills in core procedures.

The teaching schedule of academic half-day topics can be designed to span one or two years (which is encouraged) to ensure coverage of all topics. The topic schedule cycle is repeated.

The following is a snapshot of a previous Academic Half-Day Schedule:

Academic week	Section	Date	Time	Sessions	Format	Presenters
1	Pediatric Imaging	Oct 5	13:00–14:00	Welcome to the program		Program director
			14:00–15:00	Imaging of neonate brain and spine	Lecture	XY
			15:00–16:00	Imaging of neonatal chest and abdomen	Lecture	YZ
2	Pediatric Imaging	Oct 12	13:00–14:00	Congenital lung lesions	Lecture	AZ

Academic week	Section	Date	Time	Sessions	Format	Presenters
			14:00–15:00	Congenital genitourinary anomalies	Lecture	XY
			15:00–16:00	Pediatric-imaging-related article	Journal Club	Resident A
3	Pediatric Imaging	Oct 19	13:00–14:00	Imaging of liver in children	Lecture	SD
			14:00–15:00	Common ped MSK lesions	Lecture	RF
			15:00–16:00	Pediatric liver masses	Case presentation	Resident C
4	Ultrasound	Oct 26	13:00–14:00	Normal and Abnormal US Findings in Early First-Trimester Pregnancy	Lecture	KD
			14:00–15:00	Common fetal anomalies on US	Lecture	BL
			15:00–16:00	Congenital uterine anomalies	Lecture	AP

1.2 Practice-based learning

Training exposures during the daily reading sessions, during procedure performance (as in ultrasound, fluoroscopy, or interventional procedures), during discussion of cases with caring physicians, or during patient encounters (e.g., managing contrast reaction) represent excellent targets for learning.

Objectives:

- Trainees are expected to build their capacity based on self-directed learning.

- Practice-based learning allows educators to supervise trainees to become competent in the required program practical skills that ensure fulfilling knowledge, psychomotor, and/or attitude learning domains.

Training Methods:

- During the rotation, the resident is responsible for running the service, and he/she is expected to receive consultations, protocol the cases, and monitor examinations as they are being done. He/she must present and review the cases with the consultant or senior radiologist and dictate and edit the reports in a timely fashion.
- Each trainee needs to maintain a logbook documenting the procedures observed, performed under supervision, and performed independently. It would be prudent to determine the minimum number of procedures to be performed before training completion.

1.3 Daily Teaching Rounds

1.3.1 Case-Based Discussion Sessions

One-hour dedicated teaching sessions are conducted by a tutor in a classroom with all residents. These sessions should be held at least four times a week (morning and/or noon time) and should follow a hot-seat format (explained in 1.3.1.2 Training Methods below). Attendance during these sessions is recorded and must be > 80% for the year.

Objectives:

- To discuss and review imaging appearances and approaches for the diagnosis of various radiological conditions.
- To learn how to logically present and discuss radiological cases, in preparation for clinical consultations, multidisciplinary clinical–radiological meetings, or examination settings.
- To develop a sense of confidence in handling clinical discussions with peers and referring clinicians.

Training Methods:

- Cases with teaching value are preselected by the tutor.
- Cases are presented as unknowns, and a resident is selected to discuss an individual case in front of his/her colleagues (*hot-seat format*). The assigned resident follows the traditional radiologic thought process by stating the study type/technique, identifying the positive findings and pertinent negative findings, summarizing the findings, formulating and ranking a differential diagnosis, and trying to determine the likely diagnosis, as well as suggesting further management plans (in particular, recommending the most appropriate imaging workup or follow-up).
- The tutor provides immediate feedback to residents during the session and tells them whether their diagnostic approach and differential diagnosis/likely diagnosis and recommendation were appropriate. The tutor also shows the residents how to improve their performance by explaining the most appropriate diagnostic and management approach.
- To maximize the benefit of these teaching rounds, residents are encouraged to read about all (or at least some) new/difficult cases, preferably on the same day.

1.3.2 Case Presentations

Residents should organize formal resident teaching cases and materials for presentation to be presented in the academic half-day or during the morning or noon teaching rounds.

Objectives:

- Enhance residents' presentation and teaching skills (choosing interesting cases and preparing teaching material, putting it up in an appropriate presentation format, experiencing how to present and moderate sessions, and observing others' presentation styles and learning from their successes and mistakes).

- Enhance residents' learning and understanding, as preparing cases/teaching materials requires plenty of in-depth reading, which boosts engagement and promotes learning.
- Enhance residents' ability to choose the interesting cases and appropriate teaching material.

Training Methods:

- Case presentation assignments will be scheduled by the chief residents in a rotating fashion throughout the entire academic year.
- Cases should be prepared in "Hot Seat" or "OSCE-type" formats by the resident in order to present to their peers. Cases should be from real-life work (i.e., not from the Internet).
    - On *OSCE-type* case presentation, a series of cases (selected radiologic images) are shown to the residents, and they are asked to state a likely diagnosis or salient abnormality (a detailed diagnostic approach is not done in this format).
- The case presentation should be prepared in an organized format using PowerPoint, including formal teaching points.

1.3.3 Journal Club

A resident-organized journal club (1-hour sessions) should be conducted several times a year (at least once a month), either during academic half-days or during the daily teaching sessions in the training center.

Objectives:

- Help the residents develop the necessary skills for lifelong learning and motivate them to seek new medical literature.
- Sharpen residents' critical appraisal skills to detect and address studies' flaws; thus, they have the ability to acquire appropriate new information efficiently and apply it productively.
- Improve clinical practice.

Training Methods:

- The assigned residents select articles two to three weeks before the scheduled journal club. More than one resident may share a critical appraisal of one article.
- The presenting resident(s) should meet with a radiologist/mentor to discuss their presentation in advance.
- The articles should be circulated to peers one to two weeks before the journal club to read them and prepare for discussions. Pertinent questions to be covered, specific epidemiologic principles to be discussed, and helpful references are preferably shared as well.
- The articles selected should be pertinent to current practice, with emphasis on clinical and radiological dilemmas encountered in everyday life (and while on call). Some of the journal club meetings should aim to teach residents critical appraisal techniques, while others should aim to update them on new important literature and improve their clinical practice; a mixture of these should be covered throughout the journal club meetings.
    - Articles illustrating important issues regarding study design, methods, and appropriateness of the data analysis are most suitable for discussing critical appraisal techniques; in such articles, the clinical topic is less important. A full meeting might be devoted to a single article to allow for detailed dissection and discussion of such a study. Skills learned from this format will hopefully aid residents when designing their own studies and writing their manuscripts.
    - Review articles and articles addressing optimal radiologic approaches, new radiologic signs, imaging guidelines, and white papers are most suitable for improving clinical practice and keeping up with the literature.
- When a journal club meeting aims to address critical appraisal techniques, the assigned resident(s) should present and actively discuss issues related to study importance, study design, data analysis, study

validity, and clinical applicability of the study findings. Additional reading on relevant epidemiologic principles, before the journal club, is typically required to enrich the discussion of the article.

- Staff radiologists who have expertise and interest in either the content area or in critical appraisal are invited to attend and enrich the discussion.

2. Universal Topics

Universal topics are educational activities developed by SCFHS and are intended for all specialties. Priority will be given to topics as follows:

- High value
- Interdisciplinary and integrated
- Require expertise that might be beyond the availability of the local clinical training sites

Universal topics have been developed by SCFHS and are available, such as e-learning via personalized access for each trainee (to access the online modules). Each universal topic is followed by a self-assessment test. As indicated in the "executive policies of continuous assessment and annual promotion," universal topics are mandatory components of the criteria for the annual promotion of trainees from their current level of training to the subsequent level. Universal topics will be distributed over the entire training period. The trainee is required to complete 20 topics; each topic mostly takes 1:30 hours.

The table below lists some suggested universal topics relevant to radiology. For a complete list of the SCFHS's universal topics, see Appendix B (please refer to the SCFHS website for the updated list).

Training Year	Modules		Topics	
	Number	Name	Number	Name
R1	Module 1	Introduction	Topic 1	Safe drug prescribing
	Module 1	Introduction	Topic 2	Hospital acquired infections

Training Year	Modules		Topics	
	Number	Name	Number	Name
	Module 2	Cancer	Topic 6	Principles of management of cancer
	Module 4	Medical and Surgical Emergencies	Topic 15	Management of acute chest pain
	Module 4	Medical and Surgical Emergencies	Topic 16	Management of acute breathlessness
	Module 7	Ethics and Health Care	Topic 31	Occupational hazards of HCW
R2	Module 1	Introduction	Topic 3	Sepsis; SIRS; DIVC
	Module 2	Cancer	Topic 7	Side effects of chemotherapy and radiation therapy
	Module 2	Cancer	Topic 8	Oncologic emergencies
	Module 4	Medical and Surgical Emergencies	Topic 17	Management of altered sensorium
	Module 4	Medical and Surgical Emergencies	Topic 18	Management of hypotension and hypertension
	Module 7	Ethics and Health Care	Topic 32	Patient advocacy
	Module 7	Ethics and Health Care	Topic 32	Ethical issues: treatment refusal; patient autonomy
R3	Module 1	Introduction	Topic 5	Blood transfusion
	Module 2	Cancer	Topic 9	Cancer prevention
	Module 2	Cancer	Topic 10	Surveillance follow-up of cancer patients
	Module 4	Medical and Surgical Emergencies	Topic 19	Management of upper GI bleeding
	Module 4	Medical and Surgical Emergencies	Topic 20	Management of lower GI bleeding
	Module 5	Acute Care	Topic 21	Pre-operative assessment
	Module 5	Acute Care	Topic 22	Post-operative care
	Module 5	Acute Care	Topic 23	Acute pain management
	Module 5	Acute Care	Topic 24	Management of fluid in the hospitalized patient
	Module 5	Acute Care	Topic 25	Management of electrolyte imbalances
R4	Module 3	Diabetes and Metabolic Disorders	Topic 12	Management of diabetic complications
	Module 3	Diabetes and Metabolic Disorders	Topic 13	Comorbidities of obesity

Training Year	Modules		Topics	
	Number	Name	Number	Name
	Module 3	Diabetes and Metabolic Disorders	Topic 14	Abnormal ECG
	Module 6	Frail Elderly	Topic 27	Assessment of frail elderly
	Module 6	Frail Elderly	Topic 29	Prescribing drugs in the elderly
	Module 6	Frail Elderly	Topic 30	Care of the elderly
	Module 7	Ethics and health care	Topic 36	Role of doctors in death and dying

3. General Learning Opportunities

3.1 Grand rounds

Objectives:

- Train the residents how to prepare and present lectures, as well as conduct literature search on a specific topic.

Training Methods:

- A 30–40-min formal lecture is presented by residents as an overview of a specific topic, attended by all residents and radiology staff in the training center.

3.2 Quality Improvement (QI)

Objectives:

- Improve patient care and clinical workflow while increasing the confidence of residents with regard to their problem-solving abilities.
- Familiarize trainees with QI terminology and available tools and methodologies for improving the quality of technical and clinical performance in a radiology department, such as Key performance indicators (KPIs) and Plan-Do-Study-Act (PDSA) cycle.

- To refocus the content of morbidity and mortality and transform it into a platform for teaching patient safety principles and emphasizing error-reduction strategies.

Training Methods:

- Involvement in quality improvement committees, meetings and workshops.
- Morbidity and mortality conferences offer trainees an opportunity to discuss patient cases where adverse effects occur through errors or complications.
- Participate in QI projects as part of their training in systems-based practice and exercise the fundamentals of quality and performance improvement.

3.3 Annual Research/QI Day

A yearly meeting to present research or QI projects is conducted for radiologists and residents in each region. This is an excellent way to stimulate residents and consultants to become involved in research and quality improvement. It is held annually at the end of the academic year, and third-year residents present abstracts and are judged and critiqued by an experienced staff panel.

3.4 Self-Directed Learning (SDL)

Residents are encouraged to manage their time so that they can engage in self-directed learning by utilizing hospital resources such as libraries and PCs.

3.5 Continuous Professional Activities (CPD)

Residents are encouraged to plan their schedules so that they can attend specialty-related conferences and workshops.

XI. ASSESSMENT AND EVALUATION

1. Purpose of Assessment

Assessment plays a vital role in the success of postgraduate training. Assessment will guide trainees and trainers to achieve defined standards, learning outcomes, and competencies. On the other hand, the assessment will provide feedback to learners and faculty regarding curriculum development, teaching methods, and quality of the learning environment. A reliable and valid assessment is an excellent tool for assessing curriculum alignments between objectives, learning methods, and assessment methods. Finally, assessment assures patients and the public that health professionals are safe and competent to practice.

Assessment can serve the following purposes:

a. Assessment for learning: Trainers use information from trainees' performance to inform their learning for improvement. It enables educators to use information about trainees' knowledge, understanding, and skills to provide feedback to trainees about learning and how to improve.

b. Assessment as learning involves trainees in the learning process, which enables them to monitor their own progress. Trainees use self-assessment and educators' feedback to reflect on their progression. It develops and supports trainees' metacognitive skills. Assessment as learning is crucial in helping residents/fellows become lifelong learners.

c. Assessment of learning uses to demonstrate the achievement of learning. This is a graded assessment and usually counts towards the trainee's end-of-training degree.

d. Feedback and evaluation as assessment outcomes will represent quality metrics that can improve the learning experience.

Miller's Pyramid of Assessment provides a framework for assessing the trainees' clinical competences which acts as a road map for the trainers to select the assessment methods to target different clinical competencies including "knows," "knows how," "shows how," and "does" (Appendix C).

For the sake of organization, assessment will be further classified into two main categories: *formative* and *summative*.

2. Formative Assessment

2.1 General Principles

Trainees, as adult learners, should strive for feedback throughout their journey of competency from "novice" to "mastery" levels. Formative assessment (also referred to as continuous assessment) is the component of assessment that is distributed throughout the academic year aiming primarily to provide trainees with effective feedback.

Trainees should assign at least one hour to meet with their mentors every two weeks to review their performance reports (e.g., ITER, e-portfolio, mini-CEX).

Input from the overall formative assessment tools will be utilized at the end of the year to make the decision to promote each individual trainee to the subsequent training level. Formative assessment will be defined based on scientific council recommendations (usually updated and announced for each individual program at the start of the academic year).

According to the executive policy on continuous assessment (available online at: www.scfhs.org), formative assessment will have the following features that will be used based on Miller's pyramid (Appendix C):

a. Multisource: minimum four tools.
b. Comprehensive: covering all learning domains (knowledge, skills, and attitude).
c. Relevant: focusing on workplace-based observations.

d. Competency-milestone oriented: reflecting the trainee's expected competencies that match the trainee's developmental level.

Trainees should play an active role in seeking feedback during training. However, trainers are expected to provide timely and formative assessments. The SCFHS will provide an e-portfolio system to enhance communication and analysis of data arising from formative assessments.

Trainers and trainees are directed to follow the recommendations of the scientific council regarding the updated forms, frequency, distribution, and deadlines related to the implementation of evaluation forms.

2.2 Formative Assessment Tools

Learning Domain	Formative Assessment Tools	Important details (e.g., frequency, specifications related to the tool)
Knowledge	• 1. RADPrimer • 2. EYPT – Local	• RADPrimer: o Submission of > 80% of assignments before deadline over the academic year. o Accuracy over 50%. o Feedback on performance provided electronically on RADPimer platform. o The program director monitor the performance of his/her residents. • EYPT – Local: o End-of-year progress test. o Conducted for each residency level (R1 through R4). o Resident must pass the exam to complete the training year successfully. o The exam blueprint (format, content, and passing scores) is published on SCFHS website.
Skills	• 3. Logbook • 4. Mini-CEX • 5. DOPS	• Logbook: o A log of number and type of cases reported, or procedures performed

Learning Domain	Formative Assessment Tools	Important details (e.g., frequency, specifications related to the tool)
	• 6. Research Activity (R3)	o Reviewed by program director (PD) at end of each rotation. o Productivity measures are set by the Diagnostic Radiology Scientific Council as follows: *(see Appendix D for productivity numbers of different rotations*) ▪ Is productivity is below the "Critical Minimum Cut-off" → The resident FAILS the rotation ▪ If productivity is below the "Acceptable Minimum Cut-off" → The resident gets counseling + Warning letter (keep in resident electronic file) → If he/she gets below the "Critical Minimum Cut-off" in 3 rotations within a 6-month period, then he/she MUST compensate by redoing one week in one of these rotations (the program director decides which rotation is to be compensated). *This week is deducted from the resident's annual leave.* o On-call cases do not contribute to the productivity measures rules above. Time off (post-calls, academic half-days, leaves) should be deducted when calculating required productivity. o Should be separate from ITER form. • Mini-CEX: o A mini-clinical evaluation exercise (image interpretation) done at work-place (e.g. on radiology station). o Done in the training center, twice a year. o Date and time arranged between resident, program director (PD) and examining consultants (preferably in the last week of a rotation).

Learning Domain	Formative Assessment Tools	Important details (e.g., frequency, specifications related to the tool)
		o Evaluator chooses the cases and examines the trainee on it. o Feedback on performance is provided by evaluators on demand of resident o Should be separate from ITER form. • DOPS: (Direct Observation of Procedural Skills): o Assess performance of a procedure (e.g. US, IR or fluoroscopy) o Done in the training center twice a year. o Date and time are arranged between resident, program director (PD) and examining consultants (preferably in the last week of a rotation). o Evaluator chooses the cases and examines trainee on them. o Feedback on performance provided by evaluators on demand of resident o Should be separate from ITER • Research activity: o Refer to research requirements section
Attitude	• 7. Rotation ITER	• Rotation ITER: o Detailed evaluation of rotation performance provided electronically via One45 platform o Assesses resident's CanMEDS competencies, milestones, and ability to run the service. o Done at the end of each rotation. o Provided by each radiologist who supervised the resident during the rotation.

The evaluation of each component will be based on the following equation:

Percentage	< 50%	50–59.4%	59.5–69.4%	> 69.5%
Description	Clear fail	Borderline fail	Borderline pass	Clear pass

To achieve unconditioned promotion, the candidate must score a minimum of "borderline pass" in all seven components.

The program director can still recommend the promotion of candidates if the above is not met, in the following situation:

- If the candidate scored "borderline failure" in one or two components at maximum, and these scores should not belong to the same area of assessment (for example, both borderline failures should not both belong to Skills).
- The candidate must have passed all the other components and scored a minimum of clear pass in at least two components.

3. Summative Assessment

3.1 General Principles

Summative assessment is the component of assessment that aims primarily to make informed decisions on trainees' competency. In comparison to formative assessment, *summative assessment* does not aim to provide constructive feedback. For further details on this section, please refer to the general bylaws and executive policy of assessment (available online at: www.scfhs.org). To be eligible to set for the final exams, a trainee should be granted "*Certification of Training-Completion*"

3.2 First Part Examination

This is a written examination that permits the trainee to be promoted from the "junior" to "senior" level of training. For further details on the first part

examination, please refer to general bylaws and executive policy of assessment (available online at: www.scfhs.org).

The blueprint of the first part examination is shown in the following table: (*Please note that the content of the following table is for demonstration only; please refer to the most updated version published on the SCFHS website*).

Example of Written Exam Blueprint:

	Sections	Proportions (%)	Number of Items	Cognition		Domain			
				K1	K2	Anatomy	Technique	Psychology	Professional Skills & Behavior
1.	Musculoskeletal	9%	14	3	11	4	4	6	0
2.	Neuroradiology	9%	14	3	11	4	3	7	0
3.	Head and Neck	5%	7	2	5	2	2	3	0
4.	Cardiothoracic	11%	16	3	13	4	5	7	0
5.	Gastrointestinal	9%	14	4	10	3	3	8	0
6.	Genitourinary	7%	10	3	7	4	3	3	0
7.	Vascular & Interventional	5%	7	2	5	3	2	2	0
8.	Pediatrics	9%	14	3	11	4	4	6	0
9.	Nuclear Medicine	5%	8	2	6	1	2	5	0
10.	Breast Imaging	5%	7	2	5	2	3	2	0
11.	Physics	18%	27	18	9	0	27	0	0
12.	General Competencies	8%	12	0	12	0	0	0	12
Total		100%	150	45	105	31	58	49	12

* Please note that this table is just for demonstration purposes, and percentages and content are subject to change at any time. Please refer to the SCFHS website for the most up-to-date information.

3.3 Final In-Training Evaluation Report (FITER)

In addition to approval of the completion of clinical requirements (resident's logbook) by the supervising committee, FITER is also prepared by program directors for each resident at the end of his or her final year of training. This report shall be the basis for obtaining the Certificate of Training-Completion, as well as the qualification to sit for the final specialty exams.

3.4 Certification of Training-Completion

To be eligible for the final specialty examinations, each trainee is required to obtain the "*Certification of Training-Completion*" Based on the training bylaws and executive policy (please refer to the SCFHS website: www.scfhs.org), trainees will be granted the "Certification of Training-Completion" once the following criteria are fulfilled:

a. Successful completion of all training rotations.
b. Completion of training requirements (e.g., logbook, research, others) as outlined in FITER, which is approved by the scientific council/committee of specialty.
c. Clearance from SCFHS training affairs ensuring compliance with tuition payments and the completion of universal topics.
d. Passing first part examination (whenever applicable)

The "*Certification of Training-Completion*" will be issued and approved by the supervisory committee or its equivalent according to SCFHS policies.

3.5 Final Specialty Examinations

The final specialty examination is the summative assessment component that grants trainees the specialty's certification. It has two elements:

a. Final written exam: In order to be eligible for this exam, trainees are required to have "*Certification of Training-Completion*"

b. Final clinical/practical exam: Trainees will be required to pass the final written exam in order to be eligible to sit for the final clinical/practical exam.

The blueprint of the final written exam is shown in the following table: (*Please note that the content of the following table is for demonstration only; please refer to the most updated version published on the SCFHS website*; www.scfhs.org)

Example of Final Written Exam Blueprint:

	Sections	Proportions (%)	Number of Items	Cognition		Domain			
				K1	K2	Anatomy	Technique	Psychology	Professional Skills & Behavior
1.	Musculoskeletal	9%	9	2	7	1	1	7	0
2.	Neuroradiology	9%	9	2	7	1	1	7	0
3.	Head and Neck	7%	7	1	6	2	0	5	0
4.	Chest	9%	9	2	7	1	1	7	0
5.	Cardiac	5%	5	1	4	1	2	2	0
6.	Gastrointestinal	12%	12	2	10	1	2	9	0
7.	Genitourinary	8%	8	2	6	1	1	6	0
8.	Vascular & Interventional	8%	8	2	6	1	3	4	0
9.	Pediatrics	9%	9	2	7	0	2	7	0
10.	Nuclear Medicine	9%	9	2	7	0	3	6	0
11.	Breast Imaging	7%	7	2	5	0	2	5	0
12.	General Competencies	8%	8	0	8	0	0	0	8
Total		100%	100	20	80	9	18	65	8

* Please note that this table is just for demonstration purposes, and percentages and content are subject to change at any time. Please refer to the SCFHS website for the most up-to-date information.

Example of Final Practical Exam Blueprint:

	Sections	Number of Station(s)
13.	Musculoskeletal Imaging	1
14.	Neuroradiology	1
15.	Head and Neck Imaging	1
16.	Cardiothoracic Imaging	1
17.	Pediatric Imaging	1
18.	Gastrointestinal Imaging	1
19.	Genitourinary Imaging	1
20.	Breast Imaging	1
21.	Nuclear Medicine	1
22.	Interventional Radiology	1
Total		10

* Please note that this table is just for demonstration purposes, and the number, name, and content of stations are subject to change at any time. Some of these stations are structured oral examination (SOE) stations, while others are OSCE stations. Some sections can be combined at a single station. Please refer to the SCFHS website for the most up-to-date information.

For further details on the final exams, please refer to general bylaws and executive policy of assessment (available online at the SCFHS website: www.scfhs.org).

Learning Domain	Summative Assessment Tools	Passing Score
Knowledge	- Final Written Examination	At least borderline pass in each tool in accordance with the standard setting method used by the executive administration of assessment
Skills	- Objective Structured Clinical Examinations (OSCE) - Structured Oral Examinations (SOE)	At least borderline pass in each tool in accordance with the standard setting method used by the executive administration of assessment
Attitude	- FITER: Final In-Training Evaluation Report	Successfully pass FITER

XII. PROGRAM AND COURSES EVALUATION

SCFHS applies variable measures to evaluate the implementation of this curriculum. The training outcomes of this program will undergo the quality assurance framework endorsed by the Central Training Committee at the SCFHS. Trainees' assessment (both formative and summative) results will be analyzed and mapped to curriculum content. Other indicators that will be incorporated are as follows.

- Report of the annual trainees' satisfaction survey.
- Reports from trainees' evaluation of faculty members.
- Reports from trainees' evaluation of rotations.
- Reports from the annual survey of program directors.
- Data available from program accreditations.

Goal-Based Evaluation: The intended achievement of milestones will be evaluated at the end of each stage to assess the progress of the curriculum delivery, and any deficiency will be addressed in the following stage utilizing the time devoted to trainee-selected topics and professional sessions.

In addition to subject-matter opinion and best practices from benchmarked international programs, SCFHS will apply a robust method to ensure that this curriculum will utilize all the data that will be available during the revision of this curriculum in the future.

XIII. POLICIES AND PROCEDURES

This curriculum represents the means and materials outlining learning objectives with which trainees and trainers will interact to achieve the identified educational outcomes. Saudi Commission for Health Specialties (SCFHS) has a full set of "General Bylaws" and "Executive Policies" (published on the official SCFHS website) that regulate all processes related to training. General bylaws of training, assessment, and accreditation as well as executive policies on admission, registration, continuous assessment and promotion, examination, trainees' representation and support, duty hours, and leaves are examples of regulations that need to be applied. Trainees, trainers, and supervisors need to apply this curriculum in compliance with the most up-to-date bylaws and policies, which can be accessed online (please refer to the SCFHS website: www.scfhs.org).

The following sections elaborate on the leaves and on-call responsibilities pertinent to the diagnostic radiology residency training program. If there are any contradictions, the most up-to-date bylaws and policies by SCFHS (which can be accessed online via the official SCFHS website) shall prevail.

1 . Vacations, Holidays, and Special Circumstances

- In accordance with the SCFHS training rules and regulations, residents are entitled to four (4) weeks of annual leave (including weekends) and one (1) Eid holiday per year. Unused leave time cannot be carried over to the next training year.

- Before the start of the training year, residents are encouraged to submit their annual leave requests and Eid holiday preferences to the program director in order to organize the master rota accordingly.
    - The training committees/centers may elect to implement a certain minimum number of days for vacation approval.
    - Leave requests may be denied if the service would be short-staffed during the requested time period.
- The resident must attend at least 75% of any rotation; therefore, he/she cannot take more than five working days off during any single rotation, including Eid days. This limit may be exceeded in only two circumstances.
    - If the Eid vacation time designated for staff by the training center exceeds five days.
    - If there is an approved course/activity conducted by a residency program that requires resident attendance. These days will NOT be deducted from the residents' annual leave balance.

  However, in either situation, the total number of days off during any rotation must not exceed 10 working days, with no more than five days representing annual vacation days.
- If a rotation change occurs during the Eid holiday, the resident must continue in the assigned rotation and shift after the official holiday days.
- Program directors in coordination with the local supervisory committee or academic affairs in a fully accredited center may grant trainees a scientific leave that should not exceed seven working days during the training year.
- For military courses and missions, please refer to SCFHS bylaws.
- Beyond the annual leave balance, any other leave type (e.g., maternity, sick/emergency) are considered under the training pausing regulations. Sick leaves and maternity leaves will be compensated during or at the end of training. However, if sick leaves and maternity leaves together with

annual leave exceeded three months in total, then pausing regulations are applied.

- If a resident chooses to drop a rotation, the rotation must be compensated before the completion of training by deduction from the annual vacation days. Similar rules apply if the resident needs to compensate for a failed rotation.
- If more than three rotations are dropped and/or failed, then he/she must
  - continue training for that year (yet not accounted for),
  - AND repeat the training year in the subsequent year.

Please refer to the SCFHS website (www.scfhs.org.sa) for up-to-date and more detailed bylaws on leaves, training postponement, withdrawal, and pausing.

2. On-Call Duties

On-call experience can be busy and stressful, but it is an enriching educational experience and a crucial part of training.

On-call duties commence after the fourth block of R1. There should be no fewer than three calls or no more than seven calls per month. Some training centers may adopt a night-float-call system instead of the traditional 24-h on-call system; there are several ways to implement such a system; therefore, the number of calls assigned to each resident should not compromise the objectives of the rotation. Some night-float-call systems may require vacation restrictions if vacation would compromise the objectives of the rotation.

R1 residents in the third and fourth blocks should do "Shadow Calls," where they attend a couple of evenings with on-call residents, to give them a glimpse into the call dynamics before starting their own calls.

The on-call resident is expected to (this list is not comprehensive; training

centers can tailor more comprehensive rules):

- Be physically present in the hospital (in-house).
- Receive ER and inpatient CT and US studies request/consultations. Consult his/her senior whenever in doubt.
- Protocol accepted cases and arrange with responsible on-call technologist.
- Deal with contrast media adverse effects.
- Provide preliminary report on ER and inpatient CT and US studies.
    - Contact the caring physician for further clinical information, whenever needed, to help with the study interpretation. Document additional information in the report
    - Contact appropriate senior whenever unsure of findings, or their interpretation and their implication on patient's health and life.
- Serious and life-threatening conditions must be communicated directly to the caring physician/team. Document such communication in the preliminary and final reports (document the name, specialty, and number of caring physician/team you contacted, and the time and method of communication).
- Pre-dictate ER and inpatient CT and US studies.
- The training center can set its own rules with regard to:
    - ER and inpatient plain film readings
    - Who should receive requests for ER and inpatient MRI studies and who should report them?
    - Who should receive requests for ER and inpatient special procedures (e.g., fluoroscopy studies, nuclear medicine, image-guided procedures), and who should perform, supervise, and report them?
    - How to deal with ER and inpatient CT and US studies requested during the day time but not done, done but not yet reported, or reported, but report did not yet appear on the system?
    - How to deal with interpretation of outside imaging studies?

- Keep track of all requested studies, as this helps ensure that all patients receive their imaging studies in a timely fashion, and saves the radiologist's time when contacting the caring physician about major discrepancies. The basic information to be registered includes the following:
  - Patient demographics (name, MRN, age, gender)
  - Type of study
  - Clinical information / Indication for study
  - GFR and allergies
  - Patient location and extension number
  - Referring physician (name, specialty, contact number)
  - How soon the study should be done (e.g., STAT, high priority: within 1 h, routine: 2–4 hours).
  - Time of study request
  - Time technologist was informed

  Appendix E shows an *example* form for tracking imaging studies requests.
- Discuss all on-call cases with the responsible radiologist(s) the following morning.
  - Start reviewing acute/high-priority cases and questionable/complex cases.
  - Clinically significant discrepancies between the initial preliminary report and the final report must be documented and communicated to the caring physician.
- Some training centers may have second-on-call residents (senior residents). Second-on-call residents should attend with the first-on-call resident as needed (review must not exceed 2 hours per case) or provide immediate presence when requested and for ambiguous cases. They must also accompany the first-on-call residents during the case discussion with the responsible radiologist(s) the following morning.

- If entitled for a post-call off, ensure that any studied accepted overnight but not yet done are indeed endorsed to the appropriate department member, scheduled, and protocolled.

Only first-on-call residents are relieved from clinical duties for the subsequent day (after they finish the discussion of all on-call cases with the responsible radiologist(s)). Second-on-call residents will not be permitted to take the following working day off unless objective and verified circumstances can be presented to the program director.

XIV. APPENDICES

1. Appendix A: Useful Radiology Reading Material

Radiology is a very broad specialty, requiring a lot of reading and practice, yet it is impossible to cover its entire length and breadth over the four years of residency. Starting residents may feel disoriented and have difficulty figuring out what to read and where to start. There are many radiology textbooks and resources, and it can be challenging to choose from. However, carefully planned readings may require picking topics from various resources to provide comprehensive coverage of the subject. Residents should keep in mind that the ultimate goal of their hard work and reading is not the exams, but rather to become competent radiologists, and that what they read in these few years is what they will practice for life.

The following list of radiology resources is long; some are for starters, while others are more suitable for reviewing cases and what has been learned; some can be read within one rotation while others are read over multiple levels; some may have the same purpose but have different styles to suit different residents' reading styles; some are subject-specific, while others are more general encompassing all radiology subjects. Of course, residents are not required to read all of these resources but instead should carefully choose what they should read to achieve the learning objectives and become a competent and safe radiologist. Asking mentors and senior residents can help in setting reading plans.

1.1 General Foundation Books

- Core Radiology: A Visual Approach to Diagnostic Imaging; by Sun, Shi, and Mandell; 2nd edition (2021); ISBN-13: 978-1108965910

- Brant and Helms' Fundamentals of Diagnostic Radiology; Klein, Vinson, Brant, and Helms; 5th edition (2018); ISBN-13: 978-1496367396

1.2 Diagnostic approach/search pattern and differential diagnosis

- Search pattern: A systematic approach to diagnostic imaging by Tu (2020th) edition; ISBN-13: 979-8653958311
- Chapman & Nakielny's Aids to Radiological Differential Diagnosis; by Hameed Rafiee; 7th edition (2019), ISBN-13: 978-0702075391

1.3 General Review Books

- Primer of Diagnostic Imaging; Harisinghani, Chen, and Weissleder; 6th edition (2018); ISBN-13: 978-0323357746
- Aunt Minnie's Atlas and Imaging-Specific Diagnosis; by Thomas L Pope Jr.; 4th edition (2013); ISBN-13: 978-1451172157
- Crack the Core Exam series; by Prometheus Lionhart

1.4 Radiologic anatomy

- Weir & Abrahams' Imaging Atlas of Human Anatomy; Jonathan D. Spratt and others; 6th edition (2020); ISBN-13: 978-0702079269
- RadioGyan Radiological Anatomy resources:
  https://radiogyan.com/radiological-anatomy/#anatomymodules

1.5 Websites

- Radpaedia:
  https://radiopaedia.org
- Radiology Assistant:

https://radiologyassistant.nl

- ACR Case in Point:
  https://cortex.acr.org/CiP/Pages/Default
- ACR Clinical Resources (provides access to important resources such as the ACR Manual on Contrast Media, Reporting and Data Systems, ACR Appropriateness Criteria, Incidental Findings whitepapers, Practice Parameters and Technical Standards, radiology safety resources).
  https://www.acr.org/Clinical-Resources
- ACR Practice Parameter for Communication of Diagnostic Imaging Findings:
  https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CommunicationDiag.pdf
- RSNA RadReport reporting templates:
  https://www.rsna.org/practice-tools/data-tools-and-standards/radreport-reporting-templates
- ACR Communication Curriculum for Radiology Residents (to improve trainees' communication skills with patients, families, and physicians):
  https://www.acr.org/Member-Resources/rfs/learning/Communication-for-Radiology-Residents

1.6 Body CT scan

- Fundamentals of body CT; by Webb, Brant, and Major; 5th edition (2019); ISBN-13: 978-0323608329
- Gastrointestinal Imaging: The Requisites; Giles W Boland; 4th edition (2013); ISBN-13: 978-0323101998
- Textbook of Uroradiology; by Reed, and others; 5th edition (2012); ISBN-13: 978-0443102813

- Cross-sectional imaging of the abdomen and pelvis: A practical algorithmic approach; by Elsayes (2015th) edition; ISBN-13: 978-1493918836
- Gastrointestinal Imaging: A Core Review by Cummings and Hsu; 2nd edition (2021); ISBN-13: 978-1975147778
- Genitourinary Imaging: A Core Review; by Matthew S. Davenport; 2nd edition (2020); ISBN-13: 978-1975119874
- CT and MRI of the abdomen and pelvis: A teaching file; by Ros, Mortele, Pelsser, and Smitha; 3rd edition (2013); ISBN-13: 978-1451113525

1.7 Neuroradiology

- (Section II: Neuroradiology) Brant and Helms' Fundamentals of Diagnostic Radiology; by Klein, Vinson, Brant, and Helms; 5th edition (2018); ISBN-13: 978-1496367396
- Diagnostic and surgical imaging anatomy: Brain, head and neck, spine, by Harnsberger, Osborn and others; 1st edition (2006). ISBN-13: 978-1931884396
- Neuroradiology: The Requisites; by Nadgir and Yousem D.; 4th edition (2016); ISBN-13: 978-1455775682
- Neuroradiology: A Core Review; by Dubey et al.; 1st edition (2018); ISBN-13: 978-1496372505
- Neuroradiology: Spectrum and Evolution of Disease; by Small et al.; 1st edition (2018); ISBN-13: 978-0323445498
- Diagnostic Imaging: Head and Neck; Koch, Hamilton, Hudgins, and Harnsberger; 3rd edition (2016); ISBN-13: 978-0323443012
- Brain Imaging: Case Review Series, by Laurie Loevner, et al.
- Head and Neck Imaging: Case Review Series, by Nafi Aygun, et al.
- Head and Neck Imaging: Case Review Series, by David Yousem.
- Spine Imaging: Case Review Series, by Efrat Saraf-lavi
- Radiology Assistant – Neuroradiology Section:

http://www.radiologyassistant.nl/en/p420ccf62df7c1/click-for-more-information.html

1.8 Ultrasound

- Ultrasound: The Requisites; by Hertzberg and Middleton; 3rd edition (2015); ISBN-13: 978-0323086189
- Ultrasound: A Core Review; by Shrestha and Ngan; 1st edition (2017); ISBN-13: 978-1496309815
- Diagnostic ultrasound; by Rumack and Levine; 5th edition (2017); ISBN-13: 978-0323401715 (reference textbook)

1.9 Chest Imaging

Chest radiographs:

- Felson's Principles of Chest Roentgenology: A Programmed Text; by Lawrence R. Goodman; 5th edition (2020); ISBN-13: 978-0323625678
- Chest radiology: plain film patterns and differential diagnosis; by James C. Reed; 5th edition (2003); ISBN-13: 978-0323026178
- Chest Radiology: The Essentials.; Collins and Stern, 3rd edition (2014); ISBN-13: 978-1451144482
- Chest X-ray: A survival guide; Lacey, Morley, and Berman; 1st edition (2008); ISBN-13: 978-0702030468

Chest CT scan:

- Thoracic Imaging: Pulmonary and Cardiovascular Radiology; by Webb and Higgins; 3rd edition (2016); ISBN-13: 978-1496321046
- Webb, Müller and Naidich's High-Resolution CT of the Lung; by Desai Lynch Elicker et al.; 6th edition (2021); ISBN-13: 978-1975144432
- Muller's imaging of the chest: expert radiology series; by Walker and Chung; 2nd edition (2018); ISBN-13: 978-0323462259

- Fundamentals of High-Resolution Lung CT; Elicker and Webb; 2nd edition (2018); ISBN-13: 978-1496389923
- Imaging of the Chest, 2-Volume Set: Expert Radiology Series. 1st ed. 2008. Saunders
- Thoracic Imaging: The Requisites; by Jo-Anne O Shepard; 3rd edition (2018); ISBN-13: 978-0323448864
- Radiology Case Review Series: Thoracic Imaging; by Amr Ajlan and Alexander Semionov; 1st edition (2015); ISBN-13: 978-0071818087

Online resources:

- ACR Case in Point:
  https://cortex.acr.org/CiP/Pages/Default
- Radiology Assistant – Chest Section:
  https://radiologyassistant.nl/chest
- Korean Society of Thoracic Radiology Weekly Chest Cases:
  https://kstr.radiology.or.kr/weekly/

Useful Articles:

- Revisions to the TNM staging of lung cancer: rationale, significance, and clinical application Radiographic; March-April 2018
- Approach to Pulmonary Hypertension: From CT to Clinical Diagnosis. Radiographic; March-April 2018.
- Bronchiolitis: A Practical Approach for the General Radiologist. Radiographic; May-June 2017.
- ITMIG Classification of Mediastinal Compartments and Multidisciplinary Approach to Mediastinal Masses. Radiographic; March-April 2017.
- Pulmonary Tuberculosis: Role of Radiology in Diagnosis and Management. Radiographic; January-February 2017.
- Imaging Evaluation of Malignant Chest Wall Neoplasms. Radiographic; September-October 2016.

- Primary Pulmonary Lymphoid Lesions: Radiologic and Pathologic Findings. Radiographic; January-February 2016
- American Thoracic Society–European Respiratory Society Classification of the Idiopathic Interstitial Pneumonias: Advances in Knowledge since 2002. Radiographic; November-December 2015.
- Mosaic Attenuation: Etiology, Methods of Differentiation, and Pitfalls Radiographic; September-October 2015
- Smoking-related interstitial lung disease: Radiologic-clinical-pathologic correlation Radiology September 2008.
- What Every Radiologist Should Know about Idiopathic Interstitial Pneumonias. September; May 2007
- Diffuse Cystic Lung Disease at High-Resolution CT. AJR; June 2011

1.10 Musculoskeletal Imaging

- Fundamentals of Skeletal Radiology; Clyde A. Helms; 5th edition (2019); ISBN-13: 978-0323611657
- Bone and Joint Imaging; Resnick and Kransdorf; 3rd edition (2004); ISBN-13: 978-0721602707
- Arthritis in Black and White; by Brower and Flemming; 3rd edition (2012); ISBN-13: 978-1416055952
- Musculoskeletal MRI; by Major and Anderson; 3rd edition (2020); ISBN-13: 978-0323415606
- Fundamentals of Musculoskeletal Ultrasound; Jon A. Jacobson; 3rd edition (2017); ISBN-13: 978-0323445252
- Musculoskeletal Imaging: The Essentials; by Felix S. Chew; 1st edition (2018); ISBN-13: 978-1496383839
- Musculoskeletal Imaging: A Core Review; by Spicer and others; 2nd edition (2020); ISBN-13: 978-1975120450
- Musculoskeletal Imaging: The Requisites; by Manaster and others; 4th edition (2013); ISBN-13: 978-0323081771

1.11 Nuclear Medicine / PET imaging

- Nuclear Medicine and Molecular Imaging: The Requisites; by O'Malley and Ziessman; 5th edition (2020); ISBN-13: 978-0323530378 (for junior residents)
- Essentials of nuclear medicine imaging; by Mettler and Guiberteau; 7th edition (2018); ISBN-13: 978-0323483193
- Nuclear Medicine and Molecular Imaging: Case Review Series; by Solnes and Ziessman; 3rd edition; ISBN-13: 978-0323529945 (for senior residents)
- Specialty Imaging: PET/CT: Oncologic Imaging with Correlative Diagnostic CT; Blodgett et al.; 1st edition (2008); ISBN-13: 978-1931884181
- RadTool Nuclear Medicine Flash Facts, by Savir-Baruch and Barron, 1st edition (2017); ISBN-13: 978-3319246345

1.12 Pediatric Imaging

- Pediatric Radiology: The Requisites; by Walters and Robertson; 4th edition (2016); ISBN-13: 978-0323323079
- Fundamentals of Pediatric Imaging; Lane F. Donnelly; 3rd edition (2021); ISBN-13: 978-0128222553
- Pediatric Imaging: The Essentials; Iyer and Chapman; 1st edition (2015); ISBN-13: 978-1451193176
- RadCases Plus Q&A Pediatric Imaging; Gunderman and Delaney; 2nd edition (2018); ISBN-13: 978-1626235199
- Caffey's Pediatric Diagnostic Imaging; Brian D. Coley; 13th edition (2019); ISBN-13: 978-0323497480 (reference textbook)
- Diagnostic Imaging: Pediatrics; by A. Carlson Merrow Jr.; 3rd edition (2016); ISBN-13: 978-0323443067 (reference textbook)

- Pediatric Radiology: Practical Imaging Evaluation of Infants and Children; by Edward Lee; 1st edition (2017); ISBN-13: 978-1451175851 (reference textbook)
- Pediatric Sonography; by Marilyn J. Siegel; 5th edition (2018); ISBN-13: 978-1605476650
- The society of pediatric radiology website: https://www.pedrad.org/Education/Resources

1.13 Breast Imaging

- ACR BI-RADS Breast Imaging and Reporting Data System: Breast imaging Atlas, 5th edition. American College of Radiology.
- Clinical Breast Imaging: The Essentials; Gilda Cardinosa; 1st edition (2014); ISBN-13: 978-1451151770
- Breast Imaging Companion; Gilda Cardinosa; 4th edition (2017); ISBN-13: 978-1496314963
- Breast Imaging: The Requisites; Ikeda and Miyake; 3rd edition (2016); ISBN-13: 978-0323329040
- Breast Imaging: Case Review Series by Cecilia M Brennecke; 2nd edition (2012); ISBN-13: 978-0323087223
- Diagnostic Imaging: Breast; Wendie A. Berg and Jessica Leung; 3rd edition (2019); ISBN-13: 978-0323548120

1.14 Body MRI

- Abdominal-pelvic MRI; by Richard C. Semelka and others; 4th edition (2016), ISBN-13: 978-1119012931
- Essentials of body MRI; by Brant and de Lange (2012th) edition; ISBN-13: 978-0199738496
- Body MRI; Evan Siegelman, 1st edition (2004); ISBN-13: 978-0721637402

- Practical guide to abdominal and pelvic MRI; by Leyendecker, Brown, and Merkle; 2nd edition (2010); ISBN-13: 978-1605471440
- Mayo Clinic Body MRI Case Review; Christine U.C. Lee and James Glockner; 1st edition (2014); ISBN-13: 978-0199915705
- CT and MRI of the abdomen and pelvis: A teaching file; by Ros, Mortele, Pelsser, and Smitha; 3rd edition (2013); ISBN-13: 978-1451113525

1.15 Fluoroscopy & Plain Films

- Practical fluoroscopy of the GI and GU tracts; by Levine, Ramchandani, and Rubesin; 1st edition (2012); ISBN-13: 978-1107001800
- Introduction to fluoroscopy: For residents & professionals alike; by Larson, Lionhart, Roh, and Colglazier; 1st edition (2018); ISBN-13: 978-1720826651
- Chapman & Nakielny's Guide to Radiological Procedures; by Nick Watson and Hefin Jones; 7th edition (2017); ISBN-13: 978-0702071669
- Mayo Clinic Gastrointestinal Imaging Review; by C. Daniel Johnson; 2nd edition (2013); ISBN-13: 978-0199862153
- Felson's Principles of Chest Roentgenology: A Programmed Text; by Lawrence R. Goodman; 5th edition (2020); ISBN-13: 978-0323625678
- Accident and Emergency Radiology, A Survival Guide; By Nigel Raby, Laurence Berman, Simon Morley, and Gerald de Lacey; 3rd edition (2014); ISBN-13: 978-0702042324
- Emergency Radiology: The Requisites; By Jorge A Soto, and Brian Lucey; 2nd Edition (2016)
- Emergency Radiology: Case Studies; by David Schwartz; 1st edition (2007); ISBN-13: 978-0071409179
- Learning Radiology: Recognizing the Basics, 4th Edition, by William Herring
- Gastrointestinal Radiology: A Pattern Approach; by Ronald L. Eisenberg; 4th edition (2002)

1.16 Emergency Radiology / Plain Films Rotations

- Mayo Clinic Gastrointestinal Imaging Review; by C. Daniel Johnson; 2nd edition (2013); ISBN-13: 978-0199862153
- Felson's Principles of Chest Roentgenology: A Programmed Text; by Lawrence R. Goodman; 5th edition (2020); ISBN-13: 978-0323625678
- Accident and Emergency Radiology, A Survival Guide; By Nigel Raby, Laurence Berman, Simon Morley, and Gerald de Lacey; 3rd edition (2014); ISBN-13: 978-0702042324
- Emergency Radiology: The Requisites; By Jorge A Soto, and Brian Lucey; 2nd Edition (2016)
- Emergency Radiology: Case Studies; by David Schwartz; 1st edition (2007); ISBN-13: 978-0071409179
- Learning Radiology: Recognizing the Basics, 4th Edition, by William Herring
- Gastrointestinal Radiology: A Pattern Approach; by Ronald L. Eisenberg; 4th edition (2002)

1.17 Interventional Radiology

Foundation:

- Vascular and Interventional Radiology: The Requisites; by Kaufman and Lee; 2nd edition (2013); ISBN-13: 978-0323045841
- Interventional Radiology: A Survival Guide; by Kessel and Robertson; 4th edition (2017); ISBN-13: 978-0702067303
- Handbook of interventional radiologic procedures; by Kandarpa, Machan, and Durham; 5th edition (2016); ISBN-13: 978-1496302076
- Pocketbook of Clinical IR: A Concise Guide to Interventional Radiology; Warhadpande, Lionberg, and Cooper; 1st edition (2019); ISBN-13: 978-1626239234

- Vascular and interventional imaging: case review series; Saad, Khaja, and Vedantham; 3rd edition (2015); ISBN-13: 978-1455776306
- Vascular and Interventional Radiology: A Core Review; by Strife and Elbich; 1st edition (2019); ISBN-13: 978-1496384393

Reference Textbooks:

- Abrams' Angiography: Interventional Radiology; Geschwind and Dake; 3rd edition (2013); ISBN-13: 978-1609137922
- Vascular and Interventional Radiology; Karim Valji; 2nd edition (2006); ISBN-13: 978-0721606217
- High-yield imaging: interventional (expert consultation); by Charles Burke and others; 1st edition (2014); ISBN-13: 978-1416061601

1.18 Cardiac imaging

- Thoracic Imaging: Pulmonary and Cardiovascular Radiology; by Webb and Higgins; 3rd edition (2016); ISBN-13: 978-1496321046
- Cardiac Imaging: The Requisites; by Lawrence Boxt and Suhny Abbara; 4th edition (2015); ISBN-13: 978-1455748655
- Cardiac CT, An Issue of Radiologic Clinics of North America, 2010 (Volume 48-4); By Jill E. Jacobs; ISBN: 978-1437725940
- Clinical Cardiac MRI; by Bogaert and Dymarkowski (2012); ISBN: 978-3642230349

1.19 Research/QI

Research Project:

- The 'Research Recipe Book' of the Royal College of Radiologists (UK) website (under the following headings: Clinical radiology - Academic radiology and research - Guidance and advice):
  https://www.rcr.ac.uk/content.aspx?PageID=1964

- Research Methods in Radiology: A Practical Guide; by Andrea S. Doria and others; 1st edition (2018); ISBN-13: 978-1604068269
- "Retrospective research in radiology from concept to publication: a stepwise guide for trainees and mentors." American Journal of Roentgenology 2014
- Radiology "Statistical Concepts Series" (published in Radiology): https://pubs.rsna.org/topic/arttype-statcon?sortBy=date&startPage=
- Statistics 101 for Radiologists: https://pubs.rsna.org/doi/pdf/10.1148/rg.2015150112
- AJR "Fundamental of Clinical Research Series" (published in American Journal of Roentgenology); Examples of this series:
    - The Challenge of Clinical Radiology Research: https://www.ajronline.org/doi/full/10.2214/ajr.176.2.176032
    - The Research Framework: https://www.ajronline.org/doi/full/10.2214/ajr.176.4.1760873
    - How to Develop and Critique a Research Protocol: https://www.ajronline.org/doi/full/10.2214/ajr.176.6.1761375
    - Data Collection in Radiology Research: https://www.ajronline.org/doi/10.2214/ajr.177.4.1770755?mobileUi=0
    - Observational Studies in Radiology: https://www.ajronline.org/doi/full/10.2214/ajr.183.5.1831203
- Biostatistics for Radiologists (Planning, Performing, and Writing a Radiologic Study): https://link.springer.com/content/pdf/10.1007%2F978-88-470-1133-5.pdf
- Biostatistics Primer for the Radiologist. AJR, 2014: https://www.ajronline.org/doi/10.2214/AJR.13.11657

- The Place of Statistical Methods in Radiology (and in the Bigger Picture): https://www.medicine.mcgill.ca/epidemiology/hanley/IntMedResidents/statistics_in_radiology.pdf

QI Project:

- Quality improvement program, Royal College of Radiologists, UK: https://www.rcr.ac.uk/content.aspx?PageID=2439
- Audit templates – AuditLive Royal College of Radiologists, UK: https://www.rcr.ac.uk/clinical-radiology/audit-and-qi/auditlive
- What is Clinical Audit?: http://www.uhbristol.nhs.uk/files/nhs-ubht/1%20What%20is%20Clinical%20Audit%20v3.pdf
- Guide to quality improvement methods London: Healthcare Quality Improvement Partnership Ltd. (HQIP) https://www.hqip.org.uk/wp-content/uploads/2018/02/guide-to-quality-improvement-methods.pdf
- Guide to Using Quality Improvement Tools to Drive Clinical Audits. London: Healthcare Quality Improvement Partnership Ltd (HQIP): https://www.hqip.org.uk/wp-content/uploads/2018/02/hqip-guide-to-using-quality-improvement-tools-to-drive-clinical-audit.pdf
- RSNA Quality Improvement Practice Tools: https://www.rsna.org/practice-tools/quality-improvement
- BMJ Open Quality: https://bmjopenquality.bmj.com
- Principles for Best Practice in Clinical Audit: https://www.nice.org.uk/media/default/About/what-we-do/Into-practice/principles-for-best-practice-in-clinical-audit.pdf
- A Practical Guide to Clinical Audit: https://www.phecit.ie/Images/PHECC/Clinical%20Practice%20Guideline

s/CPG%20Approved%20Orgs/STN019%20Practical%20Guide%20to%20Clinical%20Audit.pdf

- Requirements for Clinical Audit in Medical Radiological Practices (Diagnostic Radiology, Radiotherapy and Nuclear Medicine): https://www.radiology.ie/images/uploads/2012/01/Requirements-for-Clinical-Audit-in-Radiology-Jan-2011.pdf
- Quality and Safety in Radiology; by Abujudeh and Bruno (2012); ISBN-13: 978-0199735754
- Developing a Radiology Quality and Safety Program: A Primer.; RadioGraphics 2009: http://pubs.rsna.org/doi/pdf/10.1148/rg.294095006
- A Quality Assurance Elective for Radiology Residents; Krajewski et al.; Academic Radiology 2007: http://dx.doi.org/10.1016/j.acra.2006.10.018
- ABR Noninterpretive Skills Domain Specification & Resource Guide: https://rads.web.unc.edu/wp-content/uploads/sites/12234/2018/12/NIS-Study-Guide-2013-original-long-version.pdf

1.20 Obstetrics Ultrasound

- Ultrasound in Obstetrics and Gynecology (A Practitioner's Guide); by Kathryn A. Gill; 1st edition (2013); ISBN-13: 978-0941022804
- Callen's ultrasonography in obstetrics and gynecology; by Mary E Norton; 6th edition (2016); ISBN-13: 978-0323328340

1.21 Vascular Imaging

- Vascular ultrasound: How, why, and when; by Abigail Thrush and others; 3rd edition (2009); ISBN-13: 978-0443069185
- CT and MR angiography of the peripheral circulation: Practical approach with clinical protocols; by Mukherjee and Rajagopalan; 1st edition (2007); ISBN-13: 978-1841846064
- Introduction to vascular ultrasonography; by Pellerito and Polak; 7th edition (2019); ISBN-13: 978-0323428828

1.22 Head and Neck Imaging

- Diagnostic and Surgical Imaging Anatomy: Brain, Head and Neck, Spine, by Ric Harnsberger, et al.
- Diagnostic Imaging: Head and Neck; by Koch, Hamilton, Hudgins and Harnsberger (2016)
- Head and Neck Imaging: Case Review Series, by Nafi Aygun, et al.
- Head and Neck Imaging: Case Review Series, by Nafi Aygun, et al.
- Head and Neck Lectures on YouTube (Michigan State University Department of Radiology):

  https://youtube.com/playlist?list=PLovbk6NLAFAtJWzYUhnnp6kdRRYct7gOr

  https://youtube.com/playlist?list=PLovbk6NLAFAvUSuTsfYjt51uMsnM6XErs

1.23 Radiologic Physics

- Radiologic Physics - War Machine; by Prometheus Lionhart; 2020th edition; ISBN-13: 979-8621145941

- Review of Radiologic Physics; by Walter Huda; 4th edition (2016); ISBN-13: 978-1496325082
- Radiologic Physics: The Essentials; Zhihua Qi and Robert D. Wissman; 1st edition (2019); ISBN-13: 978-1496386298
- Duke Review of MRI Physics: Case Review Series; by Wells Mangrum and others; 2nd edition (2018); ISBN-13: 978-0323530385
- Imaging Physics Case Review; by Abrahams, Huda, and Sensakovic; 1st edition (2019); ISBN-13: 978-0323428835
- The Essential Physics of Medical Imaging; by Jerrold T. Bushberg and others; 4th edition (2020); ISBN-13: 978-1975103224 *(reference textbook)*
- RSNA Physics modules:
  https://www.rsna.org/education/trainee-resources/physics-modules
- American Association of Physicists in Medicine "Diagnostic radiology resident physics curriculum." (2018):
  https://aapm.org/education/documents/Curriculum.pdf

1.24 CanMEDS Roles

- CanMEDS Framework - The Royal College of Physicians and Surgeons of Canada:
  https://www.royalcollege.ca/rcsite/canmeds/canmeds-framework-e

1.25 Radiology Reporting Skills

- ACR Practice Guideline for Communication of Diagnostic Imaging Findings:
  https://www.acr.org/-/media/acr/files/practice-parameters/communicationdiag.pdf
- The Royal Australian and New Zealand College of Radiologists Clinical Radiology Written Report Guidelines:

https://www.ranzcr.com/college/document-library/clinical-radiology-written-report-guidelines

- The Radiology Report: A guide to thoughtful communication for radiologists and other medical professionals; by Curtis P Langlotz; 1st edition (2015); ISBN-13: 978-1515174080
- How to create a great radiology report: Hartung, Michael P., et al.; RadioGraphics 2020
- The radiology report: Are we getting the message across? Wallis, A., and P. McCoubrie, Clinical Radiology 2011
- Radiology reporting—from Hemingway to HAL? By Adrian Brady; Insights into imaging 2018
- Style guidelines for radiology reporting: a manner of speaking; by Coakley et al.; AJR 2003
- Toward best practices in radiology reporting; by Charles E. Kahn Jr et al.; Radiology 2009
- The written radiology report; by John R. Wilcox; Applied Radiology 2006
- Radiology reporting: current practices and an introduction to patient-centered opportunities for improvement; Marina I. Mityul et al.; AJR 2018
- Report communication standards; by Erik R. Ranschaert, and Jan ML Bosmans; Quality and Safety in Imaging 2017
- Khorasani, Ramin. "Optimizing communication of critical test results." Journal of the American College of Radiology 6.10 (2009): 721-723.
- Hussain, Sarwat. "Communicating critical results in radiology Journal of the American College of Radiology 7.2 (2010): 148-151.
- Anthony, Shawn G., et al. "Impact of a 4-year quality improvement initiative to improve communication of critical imaging test results." Radiology 259.3 (2011): 802-807.
- Exampele of a hospital Policy and Procedure on Critical Results Notification: Generationsþ/Northern Manhattan Network Administrative

Policy and Procedure Manual. Critical tests and reporting of critical results Available at: http: //www. cumc. columbia. edu/harlem-hospital/sites/default/files/critical-value-policy.pdf. Accessed October 10, 2021.

1.26 Interpersonal and Communications Skills

- ACR communication curriculum for radiology residents (to improve trainees' communication skills with patients, families, and physicians): https://www.acr.org/Member-Resources/rfs/learning/Communication-for-Radiology-Residents

1.27 Imaging Informatics, Artificial Intelligence and Teleradiology

- Radiology noninterpretive skills: The requirements; by Hani Abujudeh and Michael Bruno; 1st edition (2017), ISBN-13: 978-0323462976
- Wald, Christoph, et al.: "ACR introduction to the ACR Imaging IT Reference Guide." Journal of the American College of Radiology 11.12 (2014): 1195-1196.
- Morgan, Matthew B., et al. "Informatics leaders in radiology: who they are and why you need them." Journal of the American College of Radiology 11.12 (2014): 1241-1250.
- McGinty, Geraldine B., et al. "IT infrastructure in the era of imaging 3.0." Journal of the American College of Radiology11.12 (2014): 1197-1204.
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- Wang, Kenneth C., Marc Kohli, and John A. Carrino. "Technology standards in imaging: a practical overview." Journal of the American College of Radiology 11.12 (2014): 1251-1259.

- Hirschorn, David S., Elizabeth A. Krupinski, and Michael J. Flynn. "PACS displays: How to select the right display technology." Journal of the American College of radiology11.12 (2014): 1270-1276.
- Mendelson, David S., Bradley J. Erickson, and Garry Choy. "Image sharing: evolving solutions in the age of interoperability." Journal of the American College of Radiology11.12 (2014): 1260-1269.
- Andriole, Katherine P. "Security of electronic medical information and patient privacy: what you need to know." Journal of the American College of Radiology 11.12 (2014): 1212-1216.
- Weiss, David L., et al., "Radiology reporting: a closed-loop cycle from order entry to results communication." Journal of the American College of Radiology 11.12 (2014): 1226-1237.
- Morin, Richard L., Anthony Seibert, John M. Boone. "Radiation dose and safety: informatics standards and tools Journal of the American College of Radiology 11.12 (2014): 1286-1297.
- Hirschorn, David S., et al. "Use of mobile devices for medical imaging." Journal of the American College of Radiology 11.12 (2014): 1277-1285.
- Cook, Tessa, and Nagy Paul. "Business intelligence for the radiologist: making your data work for you." Journal of the American College of Radiology 11.12 (2014): 1238-1240.
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- European Society of Radiology (ESR). "What the radiologist should know about artificial intelligence–an ESR white paper." Insights into Imaging 10 (2019): 1-8.

1.28 Contrast Media Management

- ACR Manual on Contrast Media:

https://www.acr.org/-/media/ACR/files/clinical-resources/contrast_media.pdf

- RCR Standards for intravascular contrast agent administration to adult patients: https://www.rcr.ac.uk/sites/default/files/Intravasc_contrast_web.pdf
- Protocols on the Safe Use of Contrast Media in Radiology Departments (The Saudi Ministry of Health): https://www.moh.gov.sa/en/Ministry/MediaCenter/Publications/Documents/Protocols-of-CM.pdf

1.29 Quality Improvement Basics

- Radiology noninterpretive skills: The requirements; by Hani Abujudeh and Michael Bruno; 1st edition (2017), ISBN-13: 978-0323462976
- The American Board of Radiology Noninterpretive Skills Study Guide https://www.theabr.org/wp-content/uploads/2021/01/NIS-2021-Study-Guide.pdf
- Kruskal, Jonathan B., et al., "Quality improvement in radiology: basic principles and tools required to achieve success." Radiographics 31.6 (2011): 1499-1509.
- Kelly, Aine Marie, and Paul Cronin "Practical approaches to quality improvement for radiologists Radiographics 35.6 (2015): 1630-1642.

1.30 Safety in Radiology

- Radiology noninterpretive skills: The requirements; by Hani Abujudeh and Michael Bruno; 1st edition (2017), ISBN-13: 978-0323462976
- The American Board of Radiology Noninterpretive Skills Study Guide https://www.theabr.org/wp-content/uploads/2021/01/NIS-2021-Study-Guide.pdf

- European Society of Radiology (ESR) communications@ myesr. org, and the European Federation of Radiographer Societies (EFRS) info@ efrs. eu. "Patient safety in medical imaging: A joint paper of the European Society of Radiology (ESR) and the European Federation of Radiographer Societies (EFRS)." Insights into Imaging 10 (2019): 1-17.
- Busby, Lindsay P., Jesse L. Courtier, and Christine M. Glastonbury. "Bias in radiology: the how and why of misses and misinterpretations." Radiographics 38.1 (2018): 236-247.
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- Tirada, Nikki, et al., "Imaging pregnant and lactating patients." Radiographics 35.6 (2015): 1751-1765.
- Siewert, Bettina, et al.: "Practice policy and quality initiatives: strategies for optimizing staff safety in a radiology department." Radiographics 33.1 (2013): 245-261.

- McCollough, Cynthia H., et al. "Radiation exposure and pregnancy: When should we be concerned?." Radiographics27.4 (2007): 909-917.
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1.31 Radiation Safety

- Imaging Wisely - Selecting the Right Test and Considering Relative Radiation Dose: The Value of the ACR Appropriateness Criteria® https://www.imagewisely.org/Imaging-Modalities/Computed-Tomography/Selecting-the-Right-Test
- ACR Appropriateness Criteria® Radiation Dose Assessment Introduction https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf
- McCollough, Cynthia H., et al. "Strategies for reducing radiation dose in CT." Radiologic Clinics 47.1 (2009): 27-40.
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- Imaging Wisely - CT Protocol Design: https://www.imagewisely.org/Imaging-Modalities/Computed-Tomography/Protocol-Design
- Imaging Wisely - Pediatric CT and Image Gently https://www.imagewisely.org/Imaging-Modalities/Computed-Tomography/Pediatric-CT-and-Image-Gently
- ACR–SPR practice parameter for imaging pregnant or potentially pregnant adolescents and women with ionizing radiation https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Pregnant-Pts.pdf
- World Health Organization "Communicating radiation risks in pediatric imaging: information to support health care discussions about benefits and risks." (2016).
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- Radiology noninterpretive skills: The requirements; by Hani Abujudeh and Michael Bruno; 1st edition (2017), ISBN-13: 978-0323462976

1.32 Lecture Presentation Skills

- Heller III, Richard E, Ezequiel Silva III. "Preparing and Delivering Your Best Radiology Lecture." Journal of the American College of Radiology 16.5 (2019): 745-748.
- Collins, A. "Giving a PowerPoint presentation: the art of communicating effectively." RadioGraphics 24.4 (2004): 1185-1192.
- Punnen, Geethu E., Shyamkumar, N. Keshava, and Sridhar Gibikote. "Clinical Radiology Case Presentation: Do's and Don'ts." Indian Journal of Radiology and Imaging 2021.
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2. Appendix B: Universal Topics

Intent:

These are high-value interdisciplinary topics of outmost importance to the trainee. The reason for delivering the topics centrally is to ensure that every trainee receives high-quality teaching and develops essential core knowledge. These topics are common to all specialties.

Topics included here meet one or more of the following criteria:

- Impactful: these are topics that are common or life-threatening
- Interdisciplinary: hence topics that are difficult to teach by a single discipline
- Orphan: topics that are poorly represented in the undergraduate curriculum
- Practical: topics that trainees will encounter in hospital practice

Development and Delivery:

Core topics for the PG curriculum will be developed and delivered centrally by the Commission through an e-learning platform. A set of preliminary learning outcomes for each topic was developed. Content experts, in collaboration with the central team, may modify the learning outcomes.

These topics will be didactic in nature, with a focus on practical aspects of care. These topics will be more content-heavy than workshops and other face-to-face interactive sessions planned.

The suggested duration of each topic is 1:30 hours.

Assessment:

The topics will be delivered in a modular fashion. At the end of each Learning

Unit there will be an online formative assessment. After completion of all topics, there will be a combined summative assessment in the form of context-rich MCQ. All trainees must attain minimum competency in the summative assessment. Alternatively, these topics can be assessed in a summative manner, along with a specialty examination.

Some ideas: may include case studies, high-quality images, worked examples of prescribing drugs in disease states, and internet resources.

Module 1: Introduction

1. Safe drug prescribing
2. Hospital acquired infections
3. Sepsis; SIRS; DIVC
4. Antibiotic stewardship
5. Blood transfusion

Safe drug prescribing:

At the end of the Learning Unit, you should be able to:

- Recognize importance of safe drug prescribing in the healthcare
- Describe various adverse drug reactions with examples of commonly prescribed drugs that can cause such reactions.
- Apply principles of drug-drug interactions, drug-disease interactions, and drug-food interactions in common situations
- Apply principles of prescribing drugs in special situations such as renal failure and liver failure
- Apply principles of prescribing drugs in elderly, pediatric age group patients, and in pregnancy and lactation
- Promote evidence-based cost-effective prescribing
- Discuss ethical and legal framework governing safe-drug prescribing in Saudi Arabia

Hospital Acquired Infections (HAI):

At the end of the Learning Unit, you should be able to

- Discuss the epidemiology of HAI with special reference to HAI in Saudi Arabia
- Recognize HAI as one of the major emerging threats in healthcare
- Identify the common sources and set-ups of HAI
- Describe the risk factors of common HAIs such as ventilator-associated pneumonia, MRSA, CLABSI, and vancomycin-resistant enterococcus (VRE)
- Identify the role of healthcare workers in the prevention of HAI
- Determine appropriate pharmacological (e.g., selected antibiotic) and non-pharmacological (e.g., removal of indwelling catheter) measures in the treatment of HAI
- Propose a plan to prevent HAI in the workplace

Sepsis, SIRS, DIVC:

At the end of the Learning Unit, you should be able to

- Explain the pathogenesis of sepsis, SIRS, and DIVC
- Identify patient-related and non-patient-related predisposing factors of sepsis, SIRS, and DIVC
- Recognize a patient at risk of developing sepsis, SIRS, and DIVC
- Describe the complications of sepsis, SIRS, and DIVC
- Apply the principles of management of patients with sepsis, SIRS, and DIVC
- Describe the prognosis of sepsis, SIRS, and DIVC

Antibiotic Stewardship:

At the end of the Learning Unit, you should be able to:

- Recognize antibiotic resistance as one of the most pressing public health threats globally
- Describe the mechanism of antibiotic resistance
- Determine the appropriate and inappropriate use of antibiotics

- Develop a plan for safe and proper antibiotic usage plan including right indications, duration, types of antibiotics, and discontinuation
- Appraise of the local guidelines in the prevention of antibiotic resistance

Blood Transfusion:

At the end of the Learning Unit, you should be able to:

- Review the different components of blood products available for transfusion
- Recognize the indications and contraindications of blood product transfusion
- Discuss the benefits, risks, and alternative to transfusion
- Undertake consent for specific blood product transfusion
- Perform steps necessary for safe transfusion
- Develop understanding of special precautions and procedures necessary during massive transfusions
- Recognize transfusion associated reactions and provide immediate management

Module 2: Cancer

6. Principles of management of cancer
7. Side effects of chemotherapy and radiation therapy
8. Oncologic emergencies
9. Cancer prevention
10. Surveillance Follow-up of cancer patients

Principles of Management of Cancer:

At the end of the Learning Unit, you should be able to:

- Discuss the basic principles of staging and grading of cancers
- Enumerate the basic principles (e.g., indications, mechanisms, types) of:
    - Cancer surgery
    - Chemotherapy

- Radiotherapy
- Immunotherapy
- Hormone therapy

Side Effects of Chemotherapy and Radiation Therapy:

At the end of the Learning Unit, you should be able to:

- Describe important side effects (e.g., frequent or life-threatening) of common chemotherapy drugs
- Explain principles of monitoring of side-effects in a patient undergoing chemotherapy
- Describe pharmacological and non-pharmacological measures available to ameliorate the side effects of commonly prescribed chemotherapy drugs
- Describe important (e.g., common and life-threatening) side effects of radiation therapy
- Describe pharmacological and non-pharmacological measures available to ameliorate the side effects of radiotherapy

Oncologic Emergencies:

At the end of the Learning Unit, you should be able to:

- Enumerate important oncologic emergencies encountered both in hospital and ambulatory settings
- Discuss the pathogenesis of important oncologic emergencies
- Recognize the oncologic emergencies
- Institute immediate measures when treating a patient with oncologic emergencies
- Counsel the patients in anticipatory manner to recognize and prevent oncologic emergencies

Cancer Prevention:

At the end of Learning Unit, you should be able to:

- Conclude that many major cancers are preventable

- Identify smoking prevention and life-style modifications as major preventable measures
- Recognize cancers that are preventable
- Discuss the major cancer prevention strategies at the individual as well as national level
- Counsel patients and families in a proactive manner regarding cancer prevention including screening

Surveillance and Follow-Up of Cancer Patients:

At the end of the Learning Unit, you should be able to:

- Describe the principles of surveillance and follow-up of patients with cancers
- Enumerate the surveillance and follow-up plan for common forms of cancer
- Describe the role of primary care physicians, family physicians, and similar others in the surveillance and follow-up of cancer patients
- Liaise with oncologists to provide surveillance and follow-up for patients with cancer

Module 3: Diabetes and Metabolic Disorders

11. Recognition and management of diabetic emergencies
12. Management of diabetic complications
13. Comorbidities of obesity
14. Abnormal ECG

Recognition and Management of Diabetic Emergencies:

At the end of the Learning Unit, you should be able to:

- Describe pathogenesis of common diabetic emergencies including their complications
- Identify risk factors and groups of patients vulnerable to such emergencies

- Recognize a patient presenting with diabetic emergencies
- Institute immediate management
- Refer the patient to appropriate next level of care
- Counsel patient and families to prevent such emergencies

Management of Diabetic Complications:

At the end of the Learning Unit, you should be able to:

- Describe the pathogenesis of important complications of Type 2 diabetes mellitus
- Screen patients for such complications
- Provide preventive measures for such complications
- Treat such complications
- Counsel patients and families with special emphasis on prevention

Comorbidities of Obesity:

At the end of the Learning Unit, you should be able to:

- Screen patients for presence of common and important comorbidities of obesity
- Manage obesity related comorbidities
- Provide dietary and life-style advice for prevention and management of obesity

Abnormal ECG:

At the end of the Learning Unit, you should be able to:

- Recognize common and important ECG abnormalities
- Institute immediate management, if necessary

Module 4: Medical and Surgical Emergencies

15. Management of acute chest pain
16. Management of acute breathlessness
17. Management of altered sensorium

18. Management of hypotension and hypertension
19. Management of upper GI bleeding
20. Management of lower GI bleeding

For all the above; following learning outcomes apply.

At the end of the Learning Unit, you should be able to:

- Triage and categorize patients
- Identify patients who need prompt medical and surgical attention
- Generate preliminary diagnoses based history and physical examination
- Order and interpret urgent investigations
- Provide appropriate immediate management to patients
- Refer the patients to next level of care, if needed

Module 5: Acute Care

21. Pre-operative assessment
22. Post-operative care
23. Acute pain management
24. Chronic pain management
25. Management of fluid in the hospitalized patient
26. Management of electrolyte imbalances

Pre-Operative Assessment:

At the end of the Learning Unit, you should be able to:

- Describe the basic principles of pre-operative assessment
- Preform pre-operative assessment in uncomplicated patient with special emphasis on:
    - General health assessment
    - Cardiorespiratory assessment
    - Medications and medical device assessment
    - Drug allergy
    - Pain relief needs

- Categorize patients according to risks

Post-Operative Care:

At the end of the Learning Unit, you should be able to:

- Devise a postoperative care plan including monitoring of vitals, pain management, fluid management, medications, and laboratory investigations
- Hand over the patients properly to appropriate facilities
- Describe the process of post-operative recovery in a patient
- Identify common post-operative complications
- Monitor patients for possible post-operative complications
- Institute immediate management for post-operative complications

Acute Pain Management:

At the end of the Learning Unit, you should be able to:

- Review the physiological basis of pain perception
- Proactively identify patients who might be in acute pain
- Assess a patient with acute pain
- Apply various pharmacological and non-pharmacological modalities available for acute pain management
- Provide adequate pain relief for uncomplicated patients with acute pain
- Identify and refer patients with acute pain who can be benefitted from specialized pain services

Chronic Pain Management:

At the end of the Learning Unit, you should be able to:

- Review bio-psychosocial and physiological basis of chronic pain perception
- Discuss various pharmacological and non-pharmacological options available for chronic pain management
- Provide adequate pain relief for uncomplicated patients with chronic pain

- Identify and refer patients with chronic pain who can be benefitted from specialized pain services

Management of Fluid in Hospitalized Patients:

At the end of the Learning Unit, you should be able to:

- Review physiological basis of water balance in the body
- Assess a patient for his/her hydration status
- Recognize a patient with over and under hydration
- Order fluid therapy (oral as well as intravenous) for a hospitalized patient
- Monitor fluid status and response to therapy through history, physical examination, and selected laboratory investigations

Management of Acid-Base Electrolyte Imbalances:

At the end of the Learning Unit, you should be able to:

- Review physiological basis of electrolyte and acid-base balance in the body
- Identify diseases and conditions that are likely to cause or be associated with acid/base and electrolyte imbalances.
- Correct electrolyte and acid-base imbalances
- Perform careful calculations, checks, and other safety measures while correcting the acid-base and electrolyte imbalances
- Monitor response to therapy through history, physical examination and selected laboratory investigations

Module 6: Frail Elderly

27. Assessment of frail elderly
28. Mini-mental state examination
29. Prescribing drugs in the elderly
30. Care of the elderly

Assessment of Frail Elderly:

At the of the Learning Unit, you should be able to

- Enumerate the differences and similarities between comprehensive assessment of elderly and assessment of other patients
- Perform comprehensive assessment, in conjunction with other members of the health care team, of a frail elderly with special emphasis on social factors, functional status, quality of life, diet and nutrition, and medication history.
- Develop a problem list based on the assessment of the elderly

Mini-Mental State Examination:

At the end of the Learning Unit, you should be able to

- Review the appropriate usages, advantages, and potential pitfalls of Mini-MSE
- Identify patients suitable for mini-MSE
- Screen patients for cognitive impairment through mini-MSE

Prescribing Drugs in the Elderly:

At the end of the Learning Unit, you should be able to

- Discuss the principles of prescribing in the elderly
- Recognize polypharmacy, prescribing cascade, inappropriate dosages, inappropriate drugs, and deliberate drug exclusion as major causes of morbidity in the elderly
- Describe physiological and functional declines in the elderly that contribute to increased drug-related adverse events
- Discuss drug-drug interactions and drug-disease interactions among the elderly
- Be familiar with Beers criteria
- Develop rational prescribing habit for the elderly
- Counsel elderly patient and family on the safe medication usage

Care of the Elderly:

At the end of the Learning Unit, you should be able to:

- Describe the factors that need to be considered while planning care for the elderly
- Recognize the needs and well-being of care-givers
- Identify the local and community resources available in the care of the elderly
- Develop, with inputs from other healthcare professionals, individualized care plan for elderly patients

Module 7: Ethics and Healthcare

31. Occupational hazards of HCW
32. Evidence based approach to smoking cessation
33. Patient advocacy
34. Ethical issues: transplantation/organ harvesting; withdrawal of care
35. Ethical issues: treatment refusal; patient autonomy
36. Role of doctors in death and dying

Occupation Hazards of Health Care Workers (HCWs):

At the end of the Learning Unit, you should be able to:

- Recognize common sources and risk factors of occupational hazards among HCWs
- Describe common occupational hazards in the workplace
- Develop familiarity with legal and regulatory frameworks governing occupational hazards among HCWs
- Develop a proactive attitude to promote workplace safety
- Protect yourself and colleagues against potential occupational hazards in the workplace

Evidence-Based Approach to Smoking Cessation:

At the end of the Learning Unit, you should be able to:

- Describe the epidemiology of smoking and tobacco usages in Saudi Arabia
- Review the effects of smoking on the smoker and family members

- Effectively use pharmacologic and non-pharmacologic measures to treat tobacco usage and dependence
- Effectively use pharmacologic and non-pharmacologic measures to treat tobacco use and dependence among special population groups such as pregnant women, adolescents, and patients with psychiatric disorders

Patient Advocacy:

At the end of the Learning Unit, you should be able to:

- Define patient advocacy
- Recognize patient advocacy as a core value governing medical practice
- Describe the role of patient advocates in the care of the patients
- Develop a positive attitude towards patient advocacy
- Be a patient advocate in conflicting situations
- Be familiar with local and national patient advocacy groups

Ethical issues: transplantation/organ harvesting; withdrawal of care:

At the end of the Learning Unit, you should be able to:

- Apply key ethical and religious principles governing organ transplantation and withdrawal of care
- Be familiar with the legal and regulatory guidelines regarding organ transplantation and withdrawal of care
- Counsel patients and families in the light of applicable ethical and religious principles
- Guide patients and families to make informed decision

Ethical issues: treatment refusal; patient autonomy:

At the end of the Learning Unit, you should be able to:

- Predict situations where a patient or family is likely to decline prescribed treatment
- Describe the concept of "rational adult" in the context of patient autonomy and treatment refusal.
- Analyze key ethical, moral, and regulatory dilemmas in treatment refusal

- Recognize the importance of patient autonomy in the decision-making process
- Counsel patients and families declining medical treatment in light of the best interest of patients

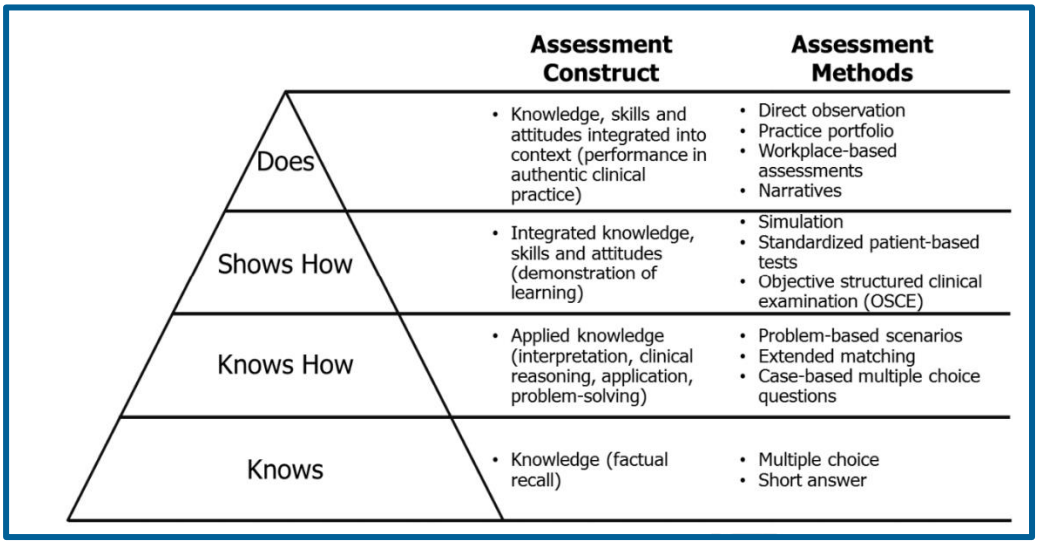
Role of Doctors in Death and Dying:

At the end of the Learning Unit, you should be able to:

- Recognize the important role a doctor can play during a dying process
- Provide emotional as well as physical care to a dying patient and family
- Provide appropriate pain management in a dying patient
- Identify suitable patients and refer to patient to palliative care services

3. Appendix C: Miller's Pyramid

Miller's Pyramid of Assessment provides a framework for assessing the trainees' clinical competences which acts a road map for the trainers to select the assessment methods to target different clinical competencies including "knows," "knows how," "shows how," and "does."



Miller's Pyramid

Adapted from:

- Walsh CM. In-training gastrointestinal endoscopy competency assessment tools: Types of tools, validation, and impact. Best Practice and Research Clinical Gastroenterology 2016 Jun 1;30(3):357-74.
- Miller GE. Assessment of clinical skills/competence/performance Acad Med. 1990;65(9 Suppl): S63–7.

4. Appendix D: Radiology Logbook Productivity Measures

The resident is responsible for tracking his/her case logbook and ensuring the achievement of the required productivity measures. The program director will check the resident's logbook at the end of each rotation to ensure that he/she meets the required productivity measures. Two cut-off thresholds are used: *Critical Minimum Cut-off* (CMC) and *Acceptable Minimum Cut-off* (AMC). The following guidelines should be used:

- If productivity is Below the "Critical Minimum Cut-off"
  → The resident FAILS the rotation

- If productivity is Below the "Acceptable Minimum Cut-off"
  → The resident receives counseling + a warning letter (kept in the resident electronic file)
  → If he/she gets Below the "Critical Minimum Cut-off" in 3 rotations within a 6-month period, then he/she MUST compensate by re-doing one week in one of these rotations (the program director decides which rotation to be compensated). *This week is deducted from the resident's annual leave.*

Please note the following:

- On-call cases do not contribute to the productivity measures rules above.
- The expected total rotation productivity measures (CMC and AMC) should be adjusted to account for the resident's time off (post-calls, academic half-days, and leaves).

The tables below show the CMC and AMC for various rotations and training levels. The total rotation CMC and AMC numbers in these tables are calculated over a period of 20 days (4-week block rotation) assuming no time off; however, residents will have time off (post-calls, academic half-days, and leaves). *Therefore, the resident and program director should account for time off, and adjust these numbers accordingly.*

Body CT Rotation	1st R1	2nd R1	1st R2	2nd R2	R3	R4
Daily CMC	5	6	7	7	8	8
Daily AMC	6	7	8	9	10	10
Weekly CMC	25	30	35	35	40	40
Weekly AMC	30	35	40	45	50	50
4-Week Block CMC	100	120	140	140	160	160
4-Week Block AMC	120	140	160	180	200	200

Neuroradiology	1st R1	2nd R1	R2	R3	1st R4	2nd R4
Daily CMC	7	8	10	12	14	14
Daily AMC	8	10	12	14	16	16
Weekly CMC	35	40	50	60	70	70
Weekly AMC	40	50	60	70	80	80
4-Week Block CMC	140	160	200	240	280	280
4-Week Block AMC	160	200	240	280	320	320

Numbers are based on CT

1 MRI = 2 CT

5 XR = 1 CT

Chest Imaging	1st R1	2nd R1	R2	R3	R4

Daily CMC	6	7	8	10	10	Numbers are based on CT
Daily AMC	7	8	10	12	12	5 XR = 1 CT
Weekly CMC	30	35	40	50	50	
Weekly AMC	35	40	50	60	60	
4-Week Block CMC	120	140	160	200	200	
4-Week Block AMC	140	160	200	240	240	

Pediatric Imaging	R1	1st R2	2nd R2	R3	R4	Numbers are based on CT
Daily CMC	0	5	6	7	8	2 US = 1 CT
Daily AMC	0	6	7	8	9	1 MRI = 2 CT
Weekly CMC	0	25	30	35	40	5 XR = 1 CT
Weekly AMC	0	30	35	40	45	1 FL = 1 CT
4-Week Block CMC	0	100	120	140	160	
4-Week Block AMC	0	120	140	160	180	

MSK Imaging	R1	1st R2	2nd R2	R3	R4	Numbers are based on CT
Daily CMC	5	7	8	9	10	1 MRI = 2 CT
Daily AMC	7	9	10	11	12	5 XR = 1 CT
Weekly CMC	25	35	40	45	50	1 FL = 1 CT
Weekly AMC	35	45	50	55	60	1 US = 1 CT
4-Week Block CMC	100	140	160	180	200	
4-Week Block AMC	140	180	200	220	240	

Ultrasound	1st R1	2nd R1	R2	R3	R4

Daily CMC	12	16	20	0	25
Daily AMC	16	20	25	0	30
Weekly CMC	60	80	100	0	125
Weekly AMC	80	100	125	0	150
4-Week Block CMC	240	320	400	0	500
4-Week Block AMC	320	400	500	0	600

Numbers are based on reported US

1 US *Scanning* = 4 reported US

Breast Imaging	R1	R2	R3	R4
Daily CMC	4	5	0	6
Daily AMC	6	8	0	10
Weekly CMC	20	25	0	30
Weekly AMC	30	40	0	50
4-Week Block CMC	80	100	0	120
4-Week Block AMC	120	160	0	200

Numbers are based on Mammo

1 US = 1 Mammo

1 MRI = 3 Mammo

1 Biopsy = 3 Mammo

Body MRI	R1	R2	R3	R4
Daily CMC	0	3	4	5
Daily AMC	0	4	5	6
Weekly CMC	0	15	20	25
Weekly AMC	0	20	25	30
4-Week Block CMC	0	60	80	100
4-Week Block AMC	0	80	100	120

Fluoroscopy & Plain Films	R1	R2	R3	R4
Daily CMC	20	0	30	0
Daily AMC	25	0	35	0
Weekly CMC	100	0	150	0

Numbers are based on XR

1 FL = 5 XR

Weekly AMC	125	0	175	0
4-Week Block CMC	400	0	600	0
4-Week Block AMC	500	0	700	0

Emergency Radiology / Plain Films	R1	R2	R3	R4
Daily CMC	25	0	0	0
Daily AMC	30	0	0	0
Weekly CMC	125	0	0	0
Weekly AMC	150	0	0	0
4-Week Block CMC	500	0	0	0
4-Week Block AMC	600	0	0	0

Interventional Radiology	R1	R2	1st R3	2nd R3	R4
Daily CMC	0	0	3	4	4
Daily AMC	0	0	4	5	6
Weekly CMC	0	0	15	20	20
Weekly AMC	0	0	20	25	30
4-Week Block CMC	0	0	60	80	80
4-Week Block AMC	0	0	80	100	120

NM/PET Imaging	R1	1st R2	2nd R2	R3	R4 (PET cases only)
Daily CMC	0	4	5	6	5
Daily AMC	0	5	6	8	7
Weekly CMC	0	20	25	30	25
Weekly AMC	0	25	30	40	35
4-Week Block CMC	0	80	100	120	100
4-Week Block AMC	0	100	120	160	140

BMD must be done, but it does NOT contribute to these numbers

Cardiac Imaging	R1	R2	R3	R4
Daily CMC	0	0	3	0
Daily AMC	0	0	4	0
Weekly CMC	0	0	15	0
Weekly AMC	0	0	20	0
4-Week Block CMC	0	0	60	0
4-Week Block AMC	0	0	80	0

Numbers are based on CT

1 MRI = 2 CT

10 XR = 1 CT

5. Appendix E: An Example Form for Tracking Imaging Studies Requests

	Patient Name	MRN	Age & Gender	Study type	Priority	Indication	GFR & Allergies	Location & Contact	Physician Name & Contact	Time study requested	Time tech. contacted	Comments
1												
2												
3												
4												
5												